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A Regional Interdisciplinary Engineering Model: Program Design and Early Alumni Outcomes

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Abstract
The National Academy of Engineering (NAE) priorities include sustainability, resilient infrastructure, health technologies, and engineered AI. Meeting these priorities requires engineers who can integrate multidisciplinary fundamentals and translate analysis into decisive action despite real-world constraints. This paper reports the design, implementation, and early outcomes of an ABET-accredited Bachelor of Science in Engineering (B.S.E.) program launched in Fall 2016 at a university in South Florida. The curriculum pairs a shared engineering core with two concentrations in Biomedical Engineering and Industrial & Systems Engineering. It also scaffolds industry-standard software tools across the program to strengthen competencies in modeling, design, data analysis, and manufacturability, drawing on research-based practices in integrated curricula and inductive, tool-enabled learning. To provide an early outcomes signal, we conducted a census alumni outcomes scan of all graduates to date (N = 39) and verified employment sector and job-role information for a subset (n = 27) using a mixed-source approach that combined alumni outreach with public professional profiles. Within the verified subset, 92.6% (25/27) were employed in engineering or engineering-adjacent roles, with infrastructure and construction as the most common sector (14/27). Where current location was identifiable (n = 38), 84.2% (32/38) were in Florida, supporting the program's regional workforce intent. These findings are presented as descriptive indicators rather than causal evidence and include an explicit "unknown/not verifiable" category where outcomes could not be confirmed. They nonetheless suggest that a common-core interdisciplinary architecture paired with tool-enabled practice can support broad employability aligned with NAE-relevant regional challenges. The paper concludes with an ABET–NAE alignment crosswalk and a roadmap for strengthening longitudinal outcomes assessment, while reserving deeper analyses for a future journal manuscript.

Keywords: NAE Grand Challenges; interdisciplinary engineering; integrated curriculum; spiral curriculum; tool-enabled learning; alumni outcomes; regional workforce; design case study

1. Introduction

Engineering work is increasingly defined by socio-technical problems that cut across traditional disciplinary boundaries: decarbonizing energy and industry, hardening infrastructure and supply chains against disruption, advancing health technologies, and deploying AI-enabled systems responsibly. The NAE's Grand Challenges framework was introduced in 2008 and sustained through the NAE Grand Challenges Project. It provides a widely recognized organizing lens for these problems [1,2]. Recent NAE forums further emphasize near-term priorities in (1) measuring and communicating sustainability progress, (2) transitioning to net-zero carbon, (3) reimagining supply chains for national resiliency, and (4) understanding the promises and perils of engineered AI systems [3–6].

These priorities imply preparation needs that extend beyond depth in a single subdiscipline. Graduates must be able to (a) apply a shared set of engineering fundamentals to unfamiliar contexts, (b) collaborate across domains, (c) use computational and data tools to model and evaluate tradeoffs, and (d) communicate technical reasoning to diverse stakeholders. ABET's

Engineering Accreditation Commission (EAC) criteria similarly emphasize problem-solving, design under constraints, communication, ethics, teamwork, and lifelong learning [7].
This paper contributes a practice-oriented case study of program-level design in engineering education: a regional, interdisciplinary B.S.E. curriculum intentionally structured to develop transferable design, analysis, and decision-making competencies aligned to ABET outcomes and NAE priorities. The program was launched in Fall 2016 at NSU to serve South Florida's workforce demands in coastal resilience and infrastructure sustainability, logistics and systems optimization, and biomedical and medical device innovation. We describe the curriculum architecture and the curricular mechanism of spiral tool integration and present an early, descriptive alumni outcomes snapshot.

Guiding questions. As a design case study, the paper is organized around two guiding questions:
(RQ1) To what extent does a spiral integration strategy, defined here as the intentional reuse of industry-standard software (SolidWorks, MATLAB, Minitab) across an interdisciplinary core, provide a scalable framework for aligning undergraduate curricula with both ABET EAC student outcomes and NAE priority signals?
(RQ2) How do early alumni outcomes (industry sectors, job roles, regional retention, and postgraduate study where available) provide initial evidence of alignment with NAE-relevant challenge areas?
Because the curriculum's engineered AI thread is under active development, this paper treats engineered AI alignment as design intent and planned enhancement within a longitudinal program design case study, rather than as a completed outcome.

2. Program context and design

South Florida is an instructive context for interdisciplinary engineering education: the region faces climate-driven risks (sea-level rise, storm surge, heat), infrastructure modernization needs, and a growing economy with strong demand in construction and project delivery, logistics and operations, and healthcare technologies. NSU established the B.S.E. as a general/interdisciplinary engineering degree rather than a set of separate traditional majors. The intent was to provide a broad, transferable engineering foundation while enabling depth through concentrations that map to regional and national needs. At the time of writing, the program enrolled approximately 40 students.

The B.S.E. curriculum is organized around (1) a common core emphasizing mathematics, physical sciences, engineering sciences, computing, and design; and (2) defined concentration pathways that provide discipline-relevant depth. Concentrations include Biomedical Engineering and Industrial & Systems Engineering. This structure is consistent with integrated curriculum approaches that seek to connect foundational concepts with authentic design and analysis contexts [8–10]. Tables 1–3 summarize the regional workforce context motivating the program and the resulting curriculum architecture and concentration pathways (course lists summarized from the official curriculum plan) [11,12].

2.1 Workforce context motivating program design (RQ1 evidence)

Florida's labor market shows sustained demand in construction/infrastructure, logistics and warehousing, healthcare, and professional/technical services. These sectors motivate the program's interdisciplinary common core and the two concentration pathways. Table 1 summarizes selected statewide indicators used to contextualize the alumni outcomes reported in Section 5.

Table 1. Selected Florida workforce signals motivating program design (summarized from statewide labor market reporting) [12].

Sector / labor market signal	Illustrative Florida indicator	Engineering-relevant implications for the B.S.E.
Construction / infrastructure	Construction employment 612,700 (July 2023); +6.5% vs. Feb 2020.	Supports emphasis on design under constraints, project management, quality, and resilient systems; aligns with infrastructure-focused placements.
Trade, transportation, utilities; warehousing & logistics	Trade/transportation/utilities employment 1,984,300 (July 2023); warehousing & storage projected growth +24.2% (2022–2030).	Motivates systems modeling, optimization, and data-driven decision making (ISE concentration and tool-enabled analytics).
Healthcare and health technology ecosystem	Healthcare and social assistance projected growth ~14.7% by 2030.	Motivates biomedical instrumentation, sensors/measurement, and human-centered design (Biomedical concentration).
Professional, scientific, and technical services (incl. architectural/engineering services)	Architectural, engineering, and related services projected growth +14.5% (2022–2030).	Reinforces core outcomes in technical communication, design documentation, and professional practice across concentrations.

2.2 Curriculum architecture and concentration pathways (RQ1 evidence)

Tables 2 and 3 summarize the program's common-core curriculum architecture and the two 15-credit concentration pathways. The common core establishes shared competencies in engineering science, design, computing, ethics, teamwork, experimentation, and communication, while the concentrations provide domain depth aligned to regional workforce needs.

Table 2. Concentration pathways (15 credits each; summarized from the official curriculum plan) [11].

Biomedical Engineering concentration	Industrial & Systems Engineering concentration
BENG 2080 Foundations of Biomedical Engineering	IENG 3010 Principles & Methods of Industrial Engineering
BENG 4030 Biomechanics and Materials	IENG 3060 Systems Optimization
BENG 4040 Physiological Systems & Modeling I	IENG 4010 Work Measurement and Human Factors
BENG 4050 Physiological Systems & Modeling II	IENG 4020 Production Systems & Facility Design
BENG 4200 Biomedical Instrumentation	IENG 4065 Discrete System Modeling

Table 3. Common-core curriculum architecture (engineering requirements; summarized from the official curriculum plan) [11].

Category (credits)	Required courses
Mathematics prerequisites (21)	MATH 2100 Calculus I (4); MATH 2200 Calculus II (4); MATH 3200 Calculus III (4); MATH 3300 Introductory Linear Algebra (3); MATH 3400 Ordinary Equations (3); MATH 4500 Probability and Statistics (3).
Science prerequisites (16)	BIOL 1500 Biology I Lab (4); CHEM 1300 General Chemistry I Lab (4); PHYS 2400 Physics I/Lab (4); PHYS 2500 Physics II/Lab (4).
Engineering core (50)	CENG 4910 Engineering Ethics Seminar (1); EENG 2710 Electrical Circuits/Lab (4); GENG 1000 Introduction to Engineering (1); GENG 1012 Engineering Graphics (3); GENG 1016 Introduction to Engineering Design (3); GENG 2000 Engineering Design and Project Management I (2); GENG 2022 Statics (3); GENG 2050 Computer Applications in Engineering (3); GENG 2070 Materials and Processes (3); GENG 2450 Dynamics (3); GENG 3000 Engineering Design and Project Management II (3); GENG 3012 Thermal and Fluid Systems (3); GENG 3024 Mechanics of Materials (3); GENG 3050 Sensors, Measurements, and Controls (3); GENG 3420 Engineering Economics (3); GENG 3800 Quality Control for Engineers (3); GENG 4010 Senior Capstone Design Project I (3); GENG 4020 Senior Capstone Design Project II (3).
Concentration (15)	Choose one concentration pathway (5 courses; 15 credits) described in Table 2.

This explicit course architecture provides the evidentiary basis for the RQ1 mapping to ABET student outcomes and NAE priority signals (Section 3).

2.3 Design principles (program-level)

Common core first: build transferable engineering fundamentals before specialization.
Depth with purpose: concentrations align to regional workforce needs and NAE-relevant problem domains. Practice authenticity: reuse professional tools and workflows across courses rather than treating software as a standalone competency. Regional relevance: capstone and project contexts are encouraged to reflect South Florida challenges (e.g., infrastructure, coastal resilience, health technologies).

3. Curricular strategy (mechanism): Spiral integration of industry-standard software tools

To bridge theory and professional practice, the B.S.E. integrates industry-standard software tools across multiple courses rather than isolating them in a single "software" class. This approach aims to (a) reinforce engineering concepts through iterative modeling and design, (b) strengthen students' ability to analyze data and uncertainty, and (c) support manufacturability and documentation practices common in industry. Tools are introduced with scaffolded assignments and then reused in later courses and projects to promote transfer and fluency.

3.1 Tool integration principles (course-level).

Contextual integration: each tool is tied to a specific engineering concept or workflow (analysis, design, quality, manufacturing). Spiral reuse: students encounter the same tool in multiple courses with increasing complexity. Decision orientation: assignments emphasize interpretation and communication of results, not only computation. Table 4 provides a curriculum-level tool-integration map showing where each software environment is introduced, reinforced (spiral reuse), and applied in capstone work.

Table 4. Curriculum-level map of spiral software-tool integration across the B.S.E. curriculum.

Software tool	Introduced (typical touchpoint)	Reused / reinforced (spiral reuse)	Capstone / signature deliverables
SolidWorks	Year 1: Engineering Graphics (GENG 1012) and early design projects (GENG 1016).	Years 2–4: Design & project management sequence (GENG 2000/3000) and prototype design documentation in core/concentration projects.	Senior Capstone (GENG 4010/4020): CAD assemblies, drawings, and design-change documentation.
MATLAB	Year 1–2: Computer Applications in Engineering (GENG 2050) introduces modeling and computation workflows.	Years 2–4: Reused in engineering science and measurement contexts (e.g., thermal/fluids; sensors/controls) and in concentration modeling assignments.	Capstone: data analysis, model validation, and trade-space exploration supporting design decisions.
Minitab	Year 2: Probability & statistics / quality methods foundations (MATH 4500; Quality Control for Engineers GENG 3800).	Years 3–4: Reinforced in quality, process improvement, and systems courses (GENG 3800; ISE concentration projects).	Capstone: statistical inference and quality/uncertainty evidence used in reports and presentations.
Mastercam	Year 2–3: Introduced through manufacturing/prototyping modules (e.g., Materials and Processes GENG 2070).	Years 3–4: Reused in fabrication-oriented assignments and prototype iterations in design courses.	Capstone: CAM toolpaths and manufacturability considerations for prototype realization.

Although these tools are not unique to interdisciplinary programs, their deliberate cross-course integration supports NAE-relevant preparation by strengthening students' ability to quantify performance, evaluate tradeoffs, and communicate results which are capabilities emphasized in recent NAE forums on sustainability measurement and net-zero transitions [3,4].

3.2 Pedagogical rationale

The spiral pattern is consistent with constructivist learning: students repeatedly apply tools in authentic contexts to build and reorganize mental models. Reusing the same software workflows across courses can also reduce extraneous cognitive load because interface syntax and routine procedures become automated, leaving more working memory available for higher-order design tradeoffs and communication in later courses and capstone projects [13], [14].

3.3 Mapping to ABET student outcomes and NAE priority signals (RQ1 evidence)

RQ1 focuses on the curricular strategy (mechanism) of spiral tool integration within a common interdisciplinary core and asks whether this strategy provides a scalable framework for ABET–NAE alignment. Table 5 provides a program-level ABET–NAE crosswalk linking the common core, concentration pathways, and tool-enabled touchpoints to representative ABET EAC student outcomes and NAE priority signals. As a proceedings design case study, this mapping is presented as design intent supported by early descriptive outcomes; course-embedded ABET indicators and longitudinal evidence are planned as future work. The engineered AI mapping is presented as the current phase of curriculum evolution (planned enhancement) rather than as an outcome claim and will be evaluated through future module pilots and course-embedded assessment.

Table 5. ABET–NAE alignment crosswalk (design intent and evidence presented in this proceedings paper; ABET outcomes numbered per EAC student outcomes [7]).

NAE priority signal	Representative ABET student outcomes (EAC 1–7)	Program design elements and curricular touchpoints	Evidence in this proceedings paper / next evidence layer
Sustainability measurement and communication [3]	1, 2, 3, 6	Tool-enabled modeling and data analysis across the core (MATLAB/Minitab); design projects requiring tradeoff analysis and clear communication; quality and measurement emphasis (GENG 3050; GENG 3800).	Tool integration map (Table 4); alumni sector/roles (Figure 1); planned: course artifact analysis and ABET outcome indicators.
Net-zero transition [4]	1, 2, 4, 7	Systems framing in the common core; ISE pathway supports optimization and simulation; biomedical pathway supports health-system efficiency and device innovation under constraints.	Curriculum architecture (Tables 2–3); early placement signals in infrastructure/construction (Figure 1); planned: capstone portfolio review and stakeholder feedback.
Supply chain resiliency [5]	1, 2, 5, 6	Industrial & Systems concentration: systems engineering, logistics, facilities design, and discrete-event simulation; reuse of analytics tools for decision support.	ISE pathway (Table 2); tool spiral (Table 4); role distribution emphasizing Operations & Management roles (Figure 1); planned: cross-tab by concentration and case-study assessments.
Engineered AI systems (promise/perils; governance) [6]	3, 4, 7	Computational foundations and model validation mindsets established with MATLAB; ethical framing through Engineering Ethics Seminar; planned AI literacy/validation module integrated into tool-based analysis contexts.	Framed as the current phase of curriculum evolution (design intent and near-term enhancement) within a longitudinal case study; planned evidence: module pilot assessment of AI literacy, validation, and ethics/governance reasoning.

4. Methods for early alumni outcomes assessment

A preliminary alumni outcomes assessment was conducted to understand early career placement patterns for program graduates and to provide a baseline for longer-term longitudinal assessment. The population for this scan included all graduates of the NSU B.S.E. program from program inception through the most recent graduating cohort available at the time of analysis (N = 39). Because early alumni samples are typically small and data availability varies, the study used a pragmatic mixed-source approach: (1) post-graduation outreach inviting alumni to self-report employment and postgraduate education via a brief survey, and (2) review of publicly available professional profiles (e.g., LinkedIn) to identify current employer, job title, industry, and location when available. Variables were coded using a consistent rubric that categorized each graduate's primary industry sector and role based on employer sector and job title/description.

To preserve interpretability, each outcome variable was coded only when verifiable. Sector and role were coded from employer and title information; postgraduate enrollment was coded when an institution/program or degree pursuit could be confirmed; and location was coded as the state of the employer when available. When employment status could not be verified but geographic information was available, the most recent self-reported or profile location was used only as a regional-retention indicator (not as evidence of employment). Unverifiable cases were coded as "unknown/not verifiable," and all figures and percentages report the applicable subset size (n) alongside the population size (N).

5. Results: early alumni outcomes

This section addresses RQ2 by summarizing early alumni outcomes using the mixed-source verification approach described in Section 4. Because outcome availability varies by variable, each figure reports the applicable subset size (n) along with the overall graduate population (N = 39). Figures 1 and 2 support interpretation of employment placement patterns alongside regional retention.

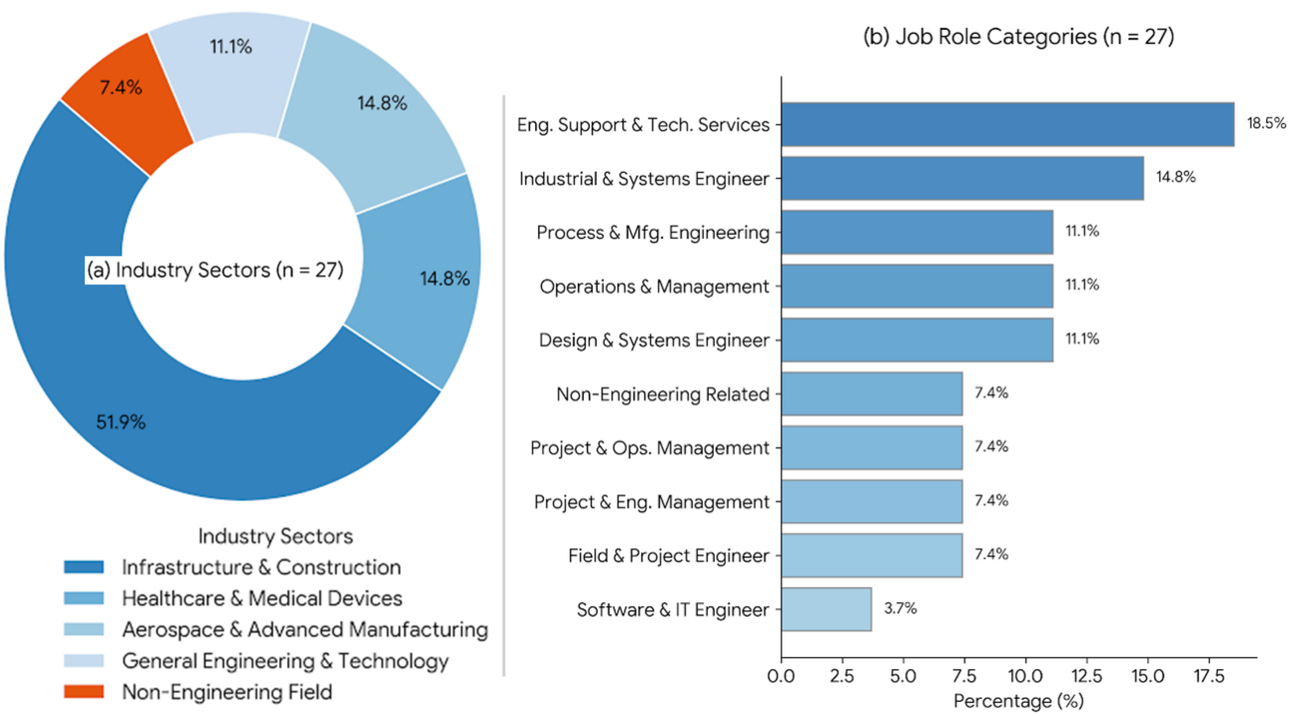

Figure 1. (a) Industry sectors among verifiable alumni outcomes (n = 27). Infrastructure & Construction is the dominant sector (51.9%), followed by Healthcare & Medical Devices and Aerospace & Advanced Manufacturing (each 14.8%). General Engineering and Non-Engineering account for 11.1% and 7.4%, respectively. (b) Job role categories among verifiable alumni outcomes (n = 27). Engineering Support & Technical Services is the largest category (18.5%),

followed by Industrial & Systems Engineering (14.8%). Process & Manufacturing, Operations & Logistics, and Design & Resilient Systems each represent 11.1%. Project Management, Field & Project Engineering, and Non-Engineering Fields each represent 7.4%, and Software & IT represents 3.7%.

Across the verifiable subset (n = 27), infrastructure and construction is the dominant sector (51.9%, 14/27), followed by healthcare & medical devices (14.8%, 4/27) and aerospace & advanced manufacturing (14.8%, 4/27). Job roles span engineering support & technical services (18.5%, 5/27), industrial & systems engineering (14.8%, 4/27), and multiple design, operations, and manufacturing roles (each 7–11%). Consistent with the program's interdisciplinary intent, 92.6% (25/27) of the verifiable subset were employed in engineering or engineering-adjacent roles, with 7.4% (2/27) in non-engineering fields. These distributions align with the regional workforce signals summarized in Table 1.

Location was identifiable for 38 of 39 graduates (n = 38) using employer location when available, or the most recent self-reported/profile location otherwise. Within this subset, 84.2% (32/38) were located in Florida and 15.8% (6/38) were located out-of-state. This indicator supports the program's regional-retention intent; however, location alone does not imply employment status and is interpreted here only as a geographic outcome proxy. To reduce re-identification risk for small cohorts, the figure emphasizes state-level retention rather than county-level reporting.

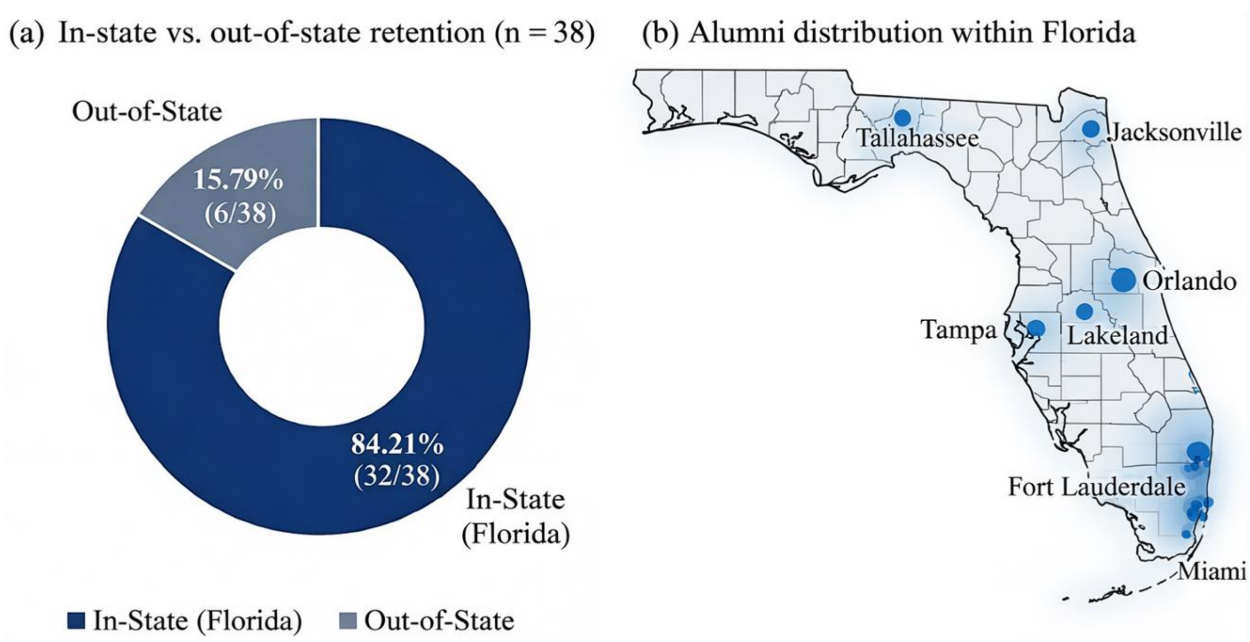

Figure 2. Regional retention and illustrative distribution within Florida (location identifiable for n = 38 of N = 39).

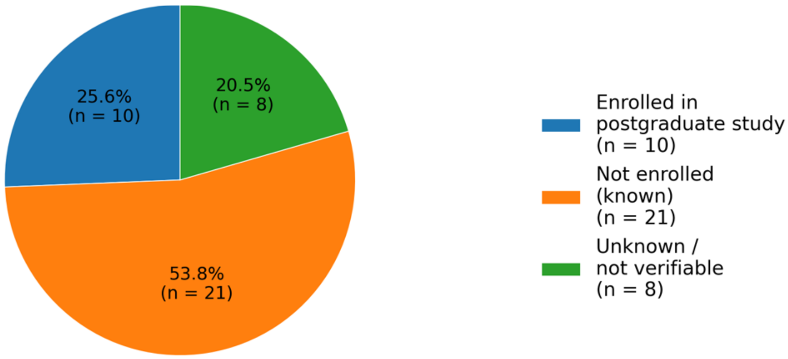

Figure 3. Postgraduate degree enrollment status with unknown shown explicitly (population N = 39; verifiable subset n = 31).

Postgraduate status was verifiable for 31 graduates (n = 31). Within this verifiable subset, 32.3% (10/31) were enrolled in postgraduate study. When the full population is considered, 10 of 39 graduates (25.6%) are known to be enrolled in postgraduate study, 21 (53.8%) are known not to be enrolled, and 8 (20.5%) are unknown/not verifiable. This distribution suggests the program supports both immediate workforce entry and preparation for advanced study.

6. Discussion

To improve readability, the discussion is organized explicitly by RQ2 (alumni outcomes) and then RQ1 (program design and alignment mapping).

RQ2: Interpreting early alumni outcomes and regional retention.

The early outcomes snapshot suggests that graduates are entering a wide range of engineering and engineering-adjacent roles (Figure 1), with a strong signal toward infrastructure/construction and operations/manufacturing functions that match regional labor market needs (Table 1). The state-level retention indicator (Figure 2) is consistent with the program's workforce-serving intent, while the postgraduate distribution (Figure 3) indicates that a meaningful fraction of graduates pursue advanced study alongside direct employment.

Because this study uses a mixed-source verification approach and reports descriptive distributions (not a first-destination placement rate), comparisons to peer institutions should be interpreted cautiously. In particular, the 92.6% figure reported here reflects the share of a verifiable subset (n = 27 of N = 39) employed in engineering or engineering-adjacent roles, while other graduates are coded as unknown/not verifiable rather than assumed employed. Publicly reported outcomes from similar Florida programs nonetheless provide useful context. For example, Embry-Riddle's multidisciplinary engineering program reports an overall placement rate of 83% [15]. In addition, Florida Atlantic University publishes FETPIP-based outcomes by department; for 2022–2023, their engineering departments report full-time employment rates ranging from 52% to 81% with continuing-education rates up to 12% [16]. These benchmarks differ in definition and data source (e.g., institutional first-destination reporting versus FETPIP in-state wage matching), but they suggest that the outcome levels observed for the NSU B.S.E. verifiable subset are within a plausible range for early-career engineering pathways.

RQ1: Spiral integration strategy as an ABET–NAE alignment framework.

RQ1 is addressed by characterizing the curricular strategy (mechanism) of spiral tool integration and showing how it scales across the interdisciplinary core and into the concentration pathways. Tables 2 and 3 document the common core and the two concentration pathways; Table 4 specifies where each tool is introduced, reinforced, and applied in capstone-level work (spiral reuse). Table 5 synthesizes these elements into an ABET–NAE alignment crosswalk, indicating the breadth of ABET outcomes and NAE priority signals the framework is designed to support. Because this is a proceedings design case study, the extent of alignment is demonstrated through program-level mapping and early descriptive outcome signals rather than causal inference; deeper course-embedded ABET indicators and longitudinal tracking remain future work.

7. Limitations

This study reports early descriptive indicators and has limitations common to alumni tracking. First, the population is small (N = 39) and several outcome variables could not be verified for all alumni, creating potential selection bias and motivating the explicit "unknown/not verifiable" category used in reporting. Second, self-reports and public professional profiles are more likely to be available (and frequently updated) for alumni who are employed and/or who wish to signal career prestige, which could skew observed sector and role distributions. Third, public profile data may be outdated, incomplete, or inconsistently reported across individuals, and role/sector coding, while based on a consistent rubric, still involves judgment. Fourth, the location indicator is interpreted as a geographic retention proxy; when employment status could not be verified, location was drawn from the most recent available profile/location information and therefore should not be interpreted as employment evidence. Finally, the analysis does not infer causal effects of the curriculum design, and comparative benchmarking is limited by differences in definitions and data sources used by peer institutions (e.g., first-destination surveys versus wage-matching datasets). These limitations motivate a more systematic longitudinal assessment strategy in future work.

8. Conclusion and future work

This paper described an ABET-accredited interdisciplinary B.S.E. program launched in Fall 2016 at NSU and documented its curriculum architecture (Tables 2–4) and alignment intent (Table 5). It also presented an early alumni outcomes snapshot for all graduates to date (N = 39), with employment sector/role information verifiable for a subset (n = 27). Results indicate that most verifiable placements are in engineering or engineering-adjacent roles, with a strong concentration in infrastructure and construction and meaningful representation in healthcare & medical devices and aerospace & advanced manufacturing (Figure 1). Where location was identifiable (n = 38), most alumni were in Florida, supporting the program's regional workforce intent (Figure 2). Postgraduate status, when verifiable (n = 31), indicates that a substantial fraction of graduates pursue advanced study (Figure 3).

Near-term improvements will focus on strengthening the evidence base while keeping the proceedings manuscript concise: (1) implementing a recurring alumni survey with standardized first-destination items; (2) establishing clear data governance and coding procedures; (3) connecting embedded course assessments to ABET outcomes; (4) incorporating targeted modules and project requirements that deepen alignment to NAE signals in sustainability measurement, net-zero transitions, supply chain resiliency, and engineered AI systems; and (5) benchmarking outcomes against publicly available peer-program reports (e.g., first-destination and/or state wage-matching datasets) with careful attention to differences in definitions. A follow-on journal manuscript will report disaggregated analyses (e.g., cohort trends, concentration comparisons, and richer career/education pathways) and triangulate findings with capstone artifacts and stakeholder feedback.

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