

# Building an Engineering Education Ecosystem Under Resource Constraints: A Retrospective Institutional Case Study from Jamaica

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## ABSTRACT

Small developing states need engineering capability to maintain infrastructure, modernise industry, and address local challenges, yet their universities often face limited capital, small specialist faculties, and uneven pre-university preparation. This retrospective institutional case study examines the development of a full engineering education ecosystem at The University of the West Indies (The UWI), Mona Campus, Jamaica. A participant-authored documentary record is triangulated with official webpages, statistical reports, quality-assurance documents, and leadership accounts. The analysis traces development from secondary school outreach and an electronics engineering degree in 2009 to a School of Engineering in 2013 and a Faculty of Engineering in 2018. Seven interacting mechanisms are identified: pipeline activation, resource-leveraged entry, programme diversification, enabling infrastructure and access, quality institutionalisation, boundary-spanning partnerships, and research-commercialisation capability. Early graduate records, international student achievements, and subsequent enrolment data provide descriptive evidence of workforce relevance and institutional durability. The case offers a transferable process model for incrementally building engineering capacity under resource constraints.

## KEYWORDS

Engineering capacity,  
Institutional  
Entrepreneurship,  
Resource bricolage,  
Small Developing  
States,  
Jamaica,  
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## Introduction

Engineering capability is foundational to economic resilience. Infrastructure, energy systems, health technologies, advanced manufacturing, digital systems, climate adaptation, and industrial productivity all depend on a workforce able not merely to operate imported technologies but to adapt, maintain, design, and commercialise solutions for local conditions. UNESCO's engineering reports connect engineering capacity directly to sustainable development and warn that shortages of trained engineers constrain implementation of the Sustainable Development Goals (UNESCO, 2010, 2021). Recent World Bank work similarly treats universities as central actors in innovation ecosystems because they

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circulate people, knowledge, and capabilities across boundaries with industry, government, and society (Garcia & Crawley, 2024).

The challenge is especially acute in small developing states. Limited public finance, modest domestic markets, outward migration, uneven preparation in mathematics and science, and the high fixed cost of laboratories make conventional programme-building difficult. A narrow response, adding a degree title without building the surrounding pipeline, facilities, quality systems, partnerships, and innovation pathways, may increase institutional commitments without producing durable national capability.

The semiconductor chapter in Reynolds's (2026) edited volume *Priority Technologies* offers a contemporary expression of the same problem. Del Alamo argues that workforce shortages cannot be solved by firm-level subsidies alone. He recommends strengthening university research and education infrastructure, expanding and creating programmes, and using hands-on, project-based, design-oriented multidisciplinary experiences from the first undergraduate year (del Alamo, 2026). Although written for the United States semiconductor sector, the logic is highly relevant to developing-country capacity building: talent supply, university capability, and regional innovation ecosystems must be developed together.

This paper examines an institutional effort that pursued such an integrated approach at The University of the West Indies (The UWI), Mona Campus, Jamaica. The case began with a secondary school-level physics outreach initiative, progressed to a BSc in Electronics Engineering launched largely from existing resources, and expanded into a School and then Faculty of Engineering with multiple programmes, international accreditation, postgraduate study, industry partnerships, and a commercial engineering company (Aiken, 2025). The paper asks:

1. How did The UWI Mona sequence the development of engineering capacity under resource and institutional constraints?
2. Which mechanisms linked the pre-university pipeline, programme growth, infrastructure, quality assurance, industry participation, research, and commercialisation?
3. What transferable principles can universities in other small developing states derive from the case?

The principal contribution is not the claim that any single practice is novel in isolation, but a staged ecosystem model showing how familiar engineering-education and capacity-building mechanisms can be sequenced, coupled and institutionalised under resource constraints. The model shifts the unit of analysis from the individual programme to the institutional and regional system needed to sustain engineering education and convert it into economic and social capability.

## Conceptual Framing

### **Engineering capacity as a development capability.**

The UNESCO engineering reports frame engineering not simply as an occupational category but as an enabling capability for sustainable development (UNESCO, 2010, 2021). In this view, national capacity depends on education, professional standards, research, inclusion, mobility, and the ability to apply knowledge to local priorities. The policy implication is that increasing graduate counts is necessary but insufficient. The quality of preparation, relevance of curricula, availability of research infrastructure, and linkages between universities and users of engineering knowledge also matter.

Innovation-system research strengthens this interpretation. Universities can educate skilled people, conduct problem-driven research, convene partners, and incubate enterprises. Their contribution depends on porous institutional boundaries through which people, ideas, equipment, and practical

problems move (Garcia & Crawley, 2024). This makes industry and public-sector partnerships a core capacity mechanism rather than an optional enhancement.

### **Activating the pre-university pipeline.**

Engineering capacity begins before university admission. The National Academies' review of K-12 engineering education found limited but promising evidence that engineering experiences can stimulate interest, strengthen understanding of engineering and technology, and provide a context for mathematics and science learning (National Academy of Engineering & National Research Council [NAE & NRC], 2009). Foundational studies of K–12 engineering outreach examine programme approaches and their broader educational impacts, providing a useful basis for understanding outreach as part of engineering-capacity development (Jeffers et al., 2004; Moskal et al., 2007). More recent work confirms that outreach and community-engagement programmes remain active areas of engineering-education research, with continuing attention to programme design, assessment, logistics, multidisciplinary participation and partner perspectives (Natarajathinam et al., 2021; Zhou, 2020).

Sundaram's IEEE Frontiers in Education model is directly relevant to the case because it emphasises direct outreach through campus visits and project days, extended outreach through digital networks, sustained secondary school-university partnerships, and tracking from intention through later engineering enrolment (Sundaram, 2015). Recent outreach research also places greater emphasis on the quality of facilitation, including how novice engineering outreach educators use “talk moves” - questions, prompts and responses that encourage students to articulate their ideas, make design decisions and explain their reasoning (Miel et al., 2023). These studies support the interpretation of outreach in this case as a pipeline-development mechanism rather than as publicity alone.

Institutional entrepreneurship and resource bricolage. Institutional entrepreneurship describes purposeful action by actors who mobilise resources and coalitions to create or transform institutions despite structural constraints (Battilana et al., 2009). Such actors do not operate outside institutions; they work through existing rules, relationships and sources of legitimacy. In universities, this includes framing a problem so that it aligns with institutional priorities, building support across academic and administrative units, and translating external needs into credible internal proposals. The foundational institutional-entrepreneurship literature is retained because it supplies the conceptual vocabulary for actor-led institutional change. Contemporary work further shows that institutional entrepreneurs draw on different combinations of field and personal resources according to their structural setting (Jackwerth-Rice et al., 2023), reinforcing the relevance of resource mobilisation to engineering-capacity development under constraint.

Resource bricolage, the creation of new capability by recombining resources already at hand, offers a complementary explanation for change under scarcity (Baker & Nelson, 2005). For engineering education, bricolage may involve adapting existing science and mathematics courses, repurposing facilities, sharing laboratories, drawing on industry practitioners and diaspora expertise, and sequencing investment as demand becomes visible. A recent systematic review confirms that bricolage remains an active and expanding construct in entrepreneurship and innovation studies, particularly for explaining who recombines resources, under what conditions, through which processes, and with what outcomes (Mateus & Sarkar, 2024). Bricolage is not equivalent to accepting inadequate provision: it is a transitional strategy for initiating capability while building the evidence, partnerships and revenue needed for more durable infrastructure.

### **From programme creation to an engineering ecosystem.**

The literature and case materials support an ecosystem conception with three linked domains. First is the talent pathway: awareness, preparation, admission, access support, retention, and progression. Second is institutional capability: curricula, faculty, laboratories, governance, finance, quality

assurance, and accreditation. Third is external translation: industry partnerships, internships, applied research, professional services, entrepreneurship, and commercialisation. Capacity becomes durable when these domains reinforce one another rather than operating as separate projects. Recent African engineering-education research similarly argues that project-based reform in resource-constrained environments requires systemic alignment among curriculum, faculty readiness, institutional support and external partnerships, together with adaptation to local conditions (Wilberforce et al., 2025). Cross-university, interdisciplinary problem-based learning also shows how institutional boundaries can be crossed to combine perspectives and capabilities that no single unit holds alone (Berg-Postweiler & Leicht-Scholten, 2025).

## Approach and Evidence

### Case design and sources.

This study uses a retrospective, embedded institutional case-study design (Yin, 2018). The primary case is the development of engineering education at The UWI Mona from the pre-programme outreach period beginning in 2007 through the formation of the Faculty of Engineering in 2018 and subsequent programme and commercialisation activities. The embedded units are: (1) secondary school outreach and recruitment; (2) the initial Electronics Engineering programme; (3) the School of Engineering; (4) access and student-financing mechanisms; (5) accreditation and continuous improvement; (6) partnerships and internships; and (7) Mona-Tech Engineering Services Limited and research-commercialisation activity.

The study uses a source-triangulation strategy appropriate to a retrospective participant-observer case. The principal historical source is the participant-authored published case record (Aiken, 2025), which contains the author's contemporaneous programme records, dated institutional chronology, application and financial figures, graduate-tracking tables, and a detailed account of programme development. These data are corroborated where possible with current Faculty of Engineering webpages and official statistical reports published by The UWI Mona, programme-level public data, continuous-improvement documentation, and external literature (The UWI, 2022, 2024, 2026a, 2026b, 2026c). The book is therefore treated as a primary documentary source and reflective practitioner account, not as independent evaluation.

The published case record underwent senior academic and institutional scrutiny before publication. Professor Brian Copeland, former Dean of Engineering and former Principal of The UWI St Augustine, and Professor Ishenkumba Kahwa, former Head of Chemistry and former Deputy Principal of The UWI Mona, reviewed the book manuscript; Kahwa also contributed its foreword. Professor Archibald McDonald, the former Mona Campus Principal whose administration supported the initiative, supplied a published retrospective assessment reproduced on the book's back cover. Their roles and involvement across the development chronology are identified in the book. These accounts strengthen confidence in the sequence of major events, but they are treated as corroborative documentary testimony rather than independent evaluation of programme outcomes (Aiken, 2025).

### Researcher positionality and reflexivity.

The paper is solely authored. The author was the principal institutional actor in the case: he proposed and led programme development, directed the Mona School of Engineering, served as the inaugural Dean of the Faculty of Engineering, and served as founding Managing Director of Mona-Tech Engineering Services Limited during part of the period studied. He also independently authored the 2025 book on which the primary documentary record is based. This proximity provides access to decision rationales and process detail that would be difficult for an external researcher to reconstruct,

but it creates risks of selective memory, self-justification and over-attribution. Reflexive safeguards were therefore applied: claims were separated into documented events, descriptive outputs, participant interpretations and later outcomes; numerical statements were traced to identified tables or public reports; the graduate and employment summaries were checked against programme records reproduced in the published case; and current institutional claims were limited to what public sources from The UWI Mona support. The analysis does not evaluate the researcher's leadership performance.

### Analytical procedure.

Analysis proceeds through temporal bracketing and source triangulation. Major decisions and outcomes are placed in sequence and coded against recurring capacity mechanisms: resource leverage, coalition building, pipeline development, access, experiential curriculum, infrastructure, quality systems, boundary-spanning partnerships, and commercialisation. Numerical claims are reported with their source and scope. The analysis does not infer causation from institutional growth; its purpose is analytical generalisation, identifying mechanisms and design principles that may transfer to comparable settings.

The evidence sources, triangulation strategy and interpretive boundaries are summarised in Table 1.

Table 1: Evidence sources and interpretive boundaries.

| Claim domain                        | Evidence used                                                                                                                           | Interpretive boundary                                                                                  |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Historical chronology and decisions | Aiken (2025); current Faculty history page (The UWI, 2026a)                                                                             | Establish sequence and corroborate continued institutional recognition.                                |
| Early graduate output               | Narrative totals and graduate trackers in Aiken (2025, pp. 19-24)                                                                       | Describe initial scale and documented first destinations without claiming a complete placement census. |
| Applications and access             | Application figures and Preliminary Engineering evidence in Aiken (2025); recent demand reports from The UWI Mona (The UWI, 2022, 2024) | Demonstrate the preparation bottleneck, access response and continuing demand.                         |
| Current scale                       | Official enrolment data from The UWI Mona, applications, admissions and retention reports (The UWI, 2022, 2024)                         | Show that Engineering persists as a substantial Faculty after the founding period.                     |
| Programme output                    | The UWI Mona Electronics Engineering public programme data (The UWI, 2026b)                                                             | Provide recent programme-level enrolment and graduate output.                                          |
| Quality and accreditation           | Aiken (2025); The UWI Mona continuous-improvement documentation (The UWI, 2026c)                                                        | Corroborate the enduring assessment and improvement architecture.                                      |
| Partnerships and innovation         | Aiken (2025); current partner and programme pages of The UWI Mona (The UWI, 2026a)                                                      | Confirm continuity of major programme, industry and university relationships.                          |

**Research ethics and data availability.**

This documentary institutional case analysis involved no intervention with human participants, interviews, or analysis of identifiable private student records; institutional ethics review was therefore not required. The study uses data reproduced in the author's published case record and publicly available institutional sources cited in the manuscript. Any future interviews or analysis of non-public individual-level data would require a separate ethics determination before inclusion.

**Building the Ecosystem Under Resource Constraints****Pipeline activation before programme launch.**

In 2007, The UWI Mona's Physics Department helped launch an intensive Caribbean Advanced Proficiency Examination (CAPE) physics workshop for sixth-form students. The format combined morning theory with afternoon laboratory work and rotated school groups through experiments that were difficult to provide in many schools. Attendance grew to more than 1,000 students annually within several years, and some participating schools reported substantial improvements in top-level CAPE Physics performance (Aiken, 2025). During the same period, new-student enrolment in the broader Faculty of Pure and Applied Sciences rose from approximately 300 to more than 1,200 annually. These figures are promising but must be independently verified and interpreted carefully because multiple outreach activities and contextual changes occurred concurrently.

The strategic significance of the workshop was larger than recruitment. It demonstrated latent demand, created relationships with schools, made university laboratories visible, and showed senior administrators that outreach could generate both educational value and institutional revenue. It also exposed the central pipeline problem: the region needed more engineers, yet many students had limited awareness of engineering pathways or insufficient preparation in the prerequisite subjects.

**Resource-leveraged entry: Electronics Engineering.**

The first engineering programme at Mona Campus was designed to minimise the initial resource threshold. The BSc in Electronics Engineering combined existing courses in physics, computing, and mathematics; adapted elements from The UWI's established engineering provision at the St Augustine Campus in Trinidad; and introduced new engineering and laboratory courses progressively (Aiken, 2025). The programme was launched in 2009 and graduated an inaugural cohort of six students in 2012. This staged approach converted adjacent scientific capacity into an engineering platform while delaying selected costs until enrolment and institutional commitment were established.

Resource leverage did not mean lowering the practical content. Laboratory courses, projects, industry input, and design-oriented outcomes were central. This is consistent with del Alamo's recommendation that programme expansion be accompanied by hands-on, project-based and design-oriented learning (del Alamo, 2026). Recent evidence from engineering challenge-based learning also shows how authentic projects can develop technical knowledge, prototyping and design capability while connecting students to stakeholder expectations, external expertise and professional networks (Bravo et al., 2025). These elements created a base from which subsequent programmes, laboratories, and accreditation systems could grow. Early graduate output and available destination tracking are summarised in Table 2.

The programme narrative reports growth from six graduates in 2012 to 12 in 2013, 18 in 2014 and 24 in 2015, a cumulative total of 60 graduates during the first four graduating years (Aiken, 2025, pp. 19-24). The four graduate-tracker tables in the book contain 50 named records with first employment or graduate-study destinations. Forty-nine of those records have a known destination; one 2013 record is

marked 'no data.' The 2013 tracker lists 14 names against a narrative cohort total of 12, while the tracker contains fewer names than the reported cumulative total across all four years. The annual tracker and cohort totals therefore cannot be fully reconciled from the available record. They are interpreted as descriptive tracked-outcomes records rather than a complete placement census or a basis for calculating annual placement rates.

Table 2 : Early BSc Electronics Engineering graduate output and available destination records.  
Source: compiled from Aiken (2025, pp. 19-24). Tracker counts reflect the names recorded in Figures 4(a)-4(d) and should not be interpreted as complete cohort placement rates.

| Graduation year | Reported graduates | Named tracker records | Records with known destination |
|-----------------|--------------------|-----------------------|--------------------------------|
| 2012            | 6                  | 6                     | 6                              |
| 2013            | 12                 | 14                    | 13                             |
| 2014            | 18                 | 17                    | 17                             |
| 2015            | 24                 | 13                    | 13                             |
| Total           | 60                 | 50                    | 49                             |

Note: The 2013 named tracker count exceeds the reported cohort total and the cumulative tracker count is below the reported four-year graduate total. The available records are therefore descriptive and do not support annual placement-rate calculations.

The recorded destinations nevertheless demonstrate alignment with the programme's workforce purpose. Graduates entered telecommunications, petroleum and process control, software, information technology, instrumentation, airport operations, engineering services, utilities, education and research, while several progressed directly or subsequently to graduate study. Employers appearing repeatedly include Digicel Jamaica, Petrojam, Telecis, Advanced Integrated Systems, Jamaica Public Service and The UWI Mona. These records provide descriptive evidence of occupational relevance; they do not by themselves establish long-term employment rates or causal labour-market effects.

### **From programme to School: diversification and infrastructure.**

The School of Engineering was established in 2013. Civil Engineering and Computer Systems Engineering began that year, Electrical Power Engineering followed in 2015, and Biomedical Engineering and Preliminary Engineering were added in 2017 (Aiken, 2025). Programme development was not treated as simple replication. The school adjusted its portfolio when demand was weak. For example, it discontinued the standalone Computer Systems Engineering degree, integrated its core content into Electronics Engineering, and introduced fields aligned with regional infrastructure, energy, health, and digital needs.

Physical capacity was developed through renovation and repurposing as well as new equipment acquisition. Existing campus buildings were converted into laboratories, offices, teaching and computing spaces. An equipment plan tied laboratory design to programme needs and guided financing. The approach illustrates a broader principle: programme approval, space planning, equipment specification, staffing, and financing must be designed as one system.

### **Access, preparation, and student finance.**

Application data indicated that approximately 60-70% of applicants were rejected because they lacked the required combination of advanced mathematics and physics qualifications (Aiken, 2025). The one-year Preliminary Engineering programme addressed this bottleneck by providing mathematics, physics, laboratory, writing, computing, and broader academic preparation. It converted a binary

admissions filter into a developmental pathway and increased the pool of students able to enter engineering.

Financial access was addressed through bursaries, negotiation with the national Student Loan Bureau, scholarships from operating revenue and partners, and provision of computing devices within tuition arrangements (Aiken, 2025). These measures matter analytically because the existence of qualified applicants does not guarantee enrolment. A capacity model must include both academic and financial accessibility.

### **Quality assurance and accreditation:**

International accreditation was used as a capability-building mechanism. Curriculum content, assessment, programme educational objectives, student outcomes, performance indicators, employer input, and continuous-improvement processes were aligned for ABET review (ABET, 2025). The Electronics Engineering programme was accredited in 2018, retroactive to 2015 (Aiken, 2025). The programme retained full accreditation following the 2019-2020 review cycle and remains listed as ABET accredited in the 2025-2026 Faculty handbook, demonstrating continuity through each completed review cycle since the initial award (The UWI, 2021, 2025). Accreditation therefore served not only as external recognition but also as a disciplined way to formalise evidence, feedback, governance, laboratory support, and curricular balance.

The current Faculty website continues to publish the resulting assessment architecture. It documents alignment among programme educational objectives, student outcomes and course learning outcomes; course assessment through laboratories, projects, examinations and presentations; review by curriculum and assessment committees; stakeholder evidence from alumni, employers, industry and internships; and planned interventions where performance falls below established thresholds (The UWI, 2026c). This public continuity supports the interpretation of accreditation as an enduring organisational capability rather than a one-time award.

### **Partnerships, postgraduate research, and commercialisation.**

Industry partnerships supported scholarships, internships, curriculum development, adjunct teaching, equipment, and project opportunities. Academic partnerships with institutions including Binghamton University, the University of Pennsylvania, the University of Florida, the University of Technology Jamaica, and the Caribbean Maritime Institute, now the Caribbean Maritime University, expanded access to expertise, facilities, and pathways beyond what a small institution could efficiently reproduce (Aiken, 2025). This mechanism is consistent with recent challenge-based engineering-education research showing that external partners contribute technical expertise, materials, authentic problems, stakeholder perspectives and professional networks rather than funding alone (Bravo et al., 2025). Sustainable inter-organizational collaboration also depends on aligned procedures, clear responsibilities, appropriate administrative and technical support, and incentives and resource commitments that persist after earmarked funding ends (Linse et al., 2024).

MPhil and PhD programmes commenced in 2017, extending the capacity model from undergraduate workforce preparation to knowledge creation. Mona-Tech Engineering Services Limited, incorporated in 2014, provided engineering services while creating internship, employment, prototyping, and commercialisation opportunities (Aiken, 2025). This boundary organisation linked the university to real engineering problems and offered a route through which academic capability could generate economic and social value.

The participant-authored case record also documents progression across qualification levels. Its graduate accounts include the first two Engineering PhD completions in 2021 and a graduate who progressed from the first BSc Computer Systems Engineering cohort in 2016 to become the first MPhil

graduate in Electronics and Computer Systems Engineering in 2024. The accounts connect undergraduate preparation, advanced research, international collaboration, and subsequent technical employment (Aiken, 2025, pp. 111-116). Because the testimonials were selected rather than sampled systematically, they are used as illustrative pathway evidence and not as representative measures of graduate experience.



Figure 1 : Trophies awarded for third-place finishes in the IEEE SoutheastCon Hardware/Robotics Competition. Source: Aiken (2025, p. 62).

Student performance in external competitions provides an additional descriptive indicator of the experiential and co-curricular environment. Teams from The UWI Mona IEEE Student Chapter placed third in the IEEE SoutheastCon Hardware/Robotics Competition in 2016, 2018, and 2019, and a student won first place for best paper in the student paper presentation competition in 2017 (Aiken, 2025, pp. 61-62). These achievements demonstrate repeated participation and competitive performance, but they are not treated as representative measures of outcomes for all students.

### **Faculty status and institutional consolidation.**

The University Council approved the Faculty of Engineering at Mona Campus in April 2018 for operation from August 2018 (Aiken, 2025). The Faculty consolidated governance, programme leadership, quality assurance, research, outreach, and commercialisation while using a comparatively lean administrative structure. The transition signalled that engineering had moved from a local experiment to a durable institutional mission.

Public institutional data indicate that the capacity endured after the founding period. Total Faculty of Engineering enrolment was 277 in 2019-20, 331 in 2020-21, 322 in 2021-22, 305 in 2022-23 and 330 in 2023-24 (The UWI, 2022, 2024). First-choice engineering applications reached 403 in 2023-24, with 84 new admissions, while first-year retention for the 2023-24 cohort was reported at 89.0% (The UWI, 2024). The Electronics Engineering programme separately reported 41 enrolled students in September 2023 and 12 graduates in 2022-23 (The UWI, 2026b). These later observations cannot be attributed solely to the founding decisions, but they corroborate institutional durability and continuing student demand.

Table 3: Publicly reported UWI Mona Engineering enrolment and undergraduate demand indicators.  
Sources: The UWI Mona Academic Profile/Portrait reports (The UWI, 2022, 2024).

| Academic year | Faculty enrolment | First-choice applications | New admissions |
|---------------|-------------------|---------------------------|----------------|
| 2019-20       | 277               | Not reported              | Not reported   |
| 2020-21       | 331               | 403                       | 102            |
| 2021-22       | 322               | 339                       | 66             |
| 2022-23       | 305               | 355                       | 64             |
| 2023-24       | 330               | 403                       | 84             |

The evidence supports the staged ecosystem-building model summarised in Table 4.

The case suggests seven stages. They are presented sequentially for clarity, but in practice they overlap and create feedback loops.

Table 4: The proposed staged ecosystem model for building engineering capacity.

| Stage | Capacity mechanism                         | Institutional function                                                                                                               |
|-------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Activate the pipeline                      | Secondary school outreach, authentic laboratories, engineering awareness, advising and relatable role models create informed demand. |
| 2     | Enter by leveraging adjacent capacity      | Use existing science, mathematics, computing, facilities and regional partners to lower the initial programme threshold.             |
| 3     | Diversify around national needs and demand | Add, combine or discontinue programmes based on workforce priorities, student demand and institutional capability.                   |
| 4     | Build enabling infrastructure and access   | Align laboratories, equipment, staff, academic bridges, student finance and digital access with programme growth.                    |
| 5     | Institutionalise quality                   | Use accreditation and continuous improvement to make outcomes, evidence, responsibility and feedback explicit.                       |
| 6     | Span institutional boundaries              | Use industry, government, diaspora and university partnerships for internships, scholarships, expertise, equipment and pathways.     |
| 7     | Translate capability into innovation       | Develop postgraduate research, professional services, prototypes, entrepreneurship and commercialisation mechanisms.                 |

Three cross-cutting practices sustain the stages. The first is institutional entrepreneurship: identifying a need, translating it into a feasible proposal, building coalitions, and revising the plan as approvals and constraints evolve. The second is disciplined resource coupling: linking each new commitment to a source of people, space, equipment, finance, or partnership support. The third is evidence-based legitimacy: using demand data, student outcomes, accreditation processes, employer feedback, and financial performance to justify the next stage.

Transferability. The model is transferable primarily at the level of sequence and mechanism, not at the level of institutional form. Other small states or resource-constrained universities may not have the same disciplinary base, campus governance, diaspora networks, accreditation options, or industry partners. However, the underlying sequence is more broadly applicable: make demand visible; begin from adjacent strengths; protect experiential learning; build access pathways; use external standards

to strengthen internal systems; borrow scale through partnerships; and create a mechanism for translating university capability into applied problem solving. The context-specific elements are the particular programmes, partners, financing instruments and institutional structures used in Jamaica. The transferable elements are the design logics used to connect them. This distinction is consistent with recent African evidence on PBL and CDIO implementation, which identifies common systemic requirements while cautioning that institutional adoption and educational practice must be adapted to local resources, staff readiness and organisational conditions (Wilberforce et al., 2025).

### **Why do these initiatives appear to have succeeded.**

Across the case, successful initiatives shared four features. First, each step solved an immediate institutional or national problem while also preparing the next step in the sequence. The CAPE workshop created outreach revenue and school relationships, while also revealing unmet demand for engineering pathways. The Electronics Engineering programme used existing disciplinary strengths, while also creating graduates, laboratories and credibility for later expansion. Second, the initiatives were evidence-generating: applications, enrolments, graduate destinations, accreditation outcomes and partner participation were repeatedly used to legitimise further investment. Third, the process coupled academic ambition to resource realism; programme additions were staged around available or attainable faculty, laboratory, partner and financial capacity. Fourth, the ecosystem linked symbolic legitimacy with operational capability through accreditation, competition performance, public reports, partnerships and commercial activity. This combination is more informative than the presence of any one practice alone.

## **Transferable Lessons, Limitations and Conclusion**

### **Why the ecosystem framing matters.**

The case trajectory reinforces the central implication of the engineering-capacity literature: talent shortages cannot be addressed by isolated subsidies or by increasing seats alone. Del Alamo's formulation links university research capability, programme expansion, hands-on learning, workforce development, and regional innovation ecosystems (del Alamo, 2026). The case shows how those elements can be assembled incrementally in a resource-constrained setting rather than funded as a single large-scale initiative.

The ecosystem framing also clarifies why school interventions belong in a paper about university engineering capacity. Outreach is not peripheral public relations when poor awareness, inadequate prerequisite selection, and weak laboratory access constrain the future applicant pool. Project activities can make engineering concrete; sustained partnerships can help students and teachers understand pathways; and longitudinal tracking can connect participation to later choices (National Academy of Engineering & National Research Council [NAE & NRC], 2009; Moore et al., 2014). The preliminary-year programme then carries the same developmental logic into university admissions.

The case supports seven transferable design principles for engineering educators and institutional leaders:

1. Start with a demonstrable need and a feasible entry point. A smaller programme built from adjacent strengths can create evidence and institutional confidence for later expansion.
2. Treat access as a pathway, not a gate. Academic bridges, correct subject advising, scholarships, loans and computing access enlarge the pool without lowering degree standards.
3. Preserve experiential learning while scaling. Laboratory, design, project and capstone experiences connect theory to professional practice and make engineering visible.

4. Use accreditation as an organisational learning system. The greatest value is not the label alone but the routines of measurement, stakeholder feedback and continuous improvement.
5. Borrow scale through partnerships. Small states cannot reproduce every specialist facility or expertise domain; reciprocal networks can provide reach while local capability develops.
6. Create a translation mechanism. A professional-services or commercialisation arm can connect research and teaching to real problems, prototypes, internships and revenue.
7. Build legitimacy with evidence at each stage. Demand, outcomes, finances, graduate trajectories and partner value should be documented before the next expansion decision.

### **Implementation challenges and trade-offs.**

The case also illustrates constraints that should not be underplayed. Resource leveraging can accelerate launch, but it may increase workload on existing departments and require careful management of laboratory access, staffing and course ownership. Outreach can build demand, but it requires sustained coordination with secondary schools and cannot by itself correct weaknesses in mathematics and physics preparation. Accreditation can provide discipline and external legitimacy, but it also imposes documentation and assessment burdens on small teams. Partnerships can borrow scale, but they depend on trust, continuity and mutual benefit. They may lose momentum when initial funding or individual leadership ends unless responsibilities, maintenance arrangements, decision authority, incentives and long-term resource commitments are embedded in the collaboration's design (Linse et al., 2024). Commercialisation and professional-services activity can connect teaching and research to real problems, but it must be governed so that educational quality and academic independence remain central. These trade-offs help define the conditions under which the model is likely to travel successfully.

### **Limits and rival explanations.**

The case has important limitations. It is retrospective and strongly shaped by the perspective of a principal institutional actor. The book is both a valuable primary record and a participant-authored account, so its interpretation is not independent. The graduate tracker contains fewer named records than the narrative cohort totals and therefore cannot support a complete placement-rate estimate. Growth may also reflect wider changes in national demand, university marketing, tuition policy, or labour markets rather than the engineering initiative alone. Graduate testimonials illustrate pathways but do not constitute a representative outcome study. Finally, practices that worked within The UWI Mona's regional structure and Jamaica's context may require modification elsewhere.

These limitations do not eliminate the case's value; they define its appropriate claims. The paper uses transparent source attribution, dated event chronology, descriptive cohort and destination data, and public evidence from The UWI Mona to corroborate institutional continuity. It presents a transferable process model and documented outputs, not a causal evaluation of national workforce impact.

### **Conclusion.**

Building engineering capacity in a small developing state is not a one-time programme-development task. It is a cumulative institutional process that connects early awareness and preparation to accessible degree pathways, experiential curricula, laboratories and staff, quality assurance, industry participation, research, and commercialisation. The case demonstrates one route through this process: begin with outreach and adjacent strengths, establish a credible programme, use evidence and partnerships to expand, formalise quality through accreditation, and create mechanisms that translate academic capability into national value.

The case is therefore best read as a mechanism-based guide rather than as a formula to copy literally. Its value lies in showing how outreach, programme launch, access support, experiential learning, infrastructure, accreditation, partnerships and innovation activity can reinforce one another when they are deliberately sequenced and documented. Future work should test the model against additional small-state and resource-constrained cases, with more independent evidence of graduate outcomes, employer value, student experience and national workforce effects.

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## Use of Artificial Intelligence

During preparation of the book and this manuscript, the author used OpenAI ChatGPT for copyediting, language refinement, rewording, structural editing, and editorial assistance. The tool was not used to generate or analyse research data. The author independently verified the references and factual claims, reviewed and revised all AI-assisted text, and accepts full responsibility for the integrity of the manuscript. The AI system is not an author.

## Declaration of Interest

The author reports no competing interest.

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