Engineering Mindset
INCLUSIVE MINDSET FOR THE FUTURE

THE MINDSET REPORT -
BLUEPRINT FOR CHANGE

Guidelines for Implementing Change in Undergraduate Engineering and Engineering Technology Education

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The Engineering Mindset Report
Blueprint for Change

The **Blueprint for Change** outlines a transformative vision for engineering education in the United States, driven by the urgent need to adapt to rapid technological, societal, and cultural shifts. Developed by the **American Society for Engineering Education (ASEE)** and the **National Academy of Engineering (NAE)** with support from the **National Science Foundation (NSF)**, this initiative builds on the ***2024 Engineering Mindset Report*** to propose a systemic overhaul of how engineers are educated.

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Key Objectives

- **Transform engineering education** to be learner-centered, and adaptable.
- **Broaden access**, moving beyond outdated metrics like standardized test scores.
- **Foster lifelong learners** capable of collaboration, problem-solving, and communication across varied contexts.

Six Core Themes of the Mindset Report

1. **Flexible Program Structures –** Remove barriers to entry and progression.
2. **Evidence-Based Pedagogy –** Center education around student needs and learning science.
3. **Learning Environments –** Ensure accessible and variety.
4. **Campus Readiness –** Prepare institutions for systemic change.
5. **Strategic Partnerships –** Collaborate with industry, government, and communities.
6. **Engineering a New Mindset –** Emphasize ethics, societal impact, and adaptability.

Blueprint for Change Volumes

- **Volume 1:** Guidance for institutions and support entities.
- **Volume 2:** Practical tools for faculty and program leaders to implement change.

Implementation Strategy

The blueprint is informed by four national convenings focused on:

1. **Future Industry and Research Vision (ERVA) –** Aligning education with future needs.
2. **Accreditation Reform (ABET) –** Updating standards to support innovation.
3. **Change Models in Higher Education –** Applying proven strategies for institutional transformation.
4. **Faculty Development (ASEE) –** Equipping educators to lead change.

Transformational Goals

- Improve Access: Redesign math and science pathways to reduce entry barriers.
- Boost Preparation: Integrate emerging technologies and ethics into curricula.
- Increase Persistence and Graduation: Provide mental health and peer support.
- Reward Teaching Innovation: Promote active learning and institutional flexibility.

Call to Action

The report calls for a national movement to reimagine engineering education. This includes:

- Engaging leadership at all institutional levels.
- Securing funding from a variety of sources.
- Creating pilot programs and learning communities.
- Emphasizing cultural and mindset shifts in both faculty and students.

Aligning Promotion & Tenure with the Future of Engineering Education

This topic of the *Blueprint for Change* outlines a strategic framework for transforming institutional policies—particularly **promotion and tenure (P&T)** processes—to support and reward **teaching innovation, access-oriented excellence, and educational leadership** in engineering education.

Why Change Promotion & Tenure Now?

- **Persistent lack of varied perspectives** in engineering limits innovation and participation.
- **Workforce demands** require graduates with interdisciplinary, adaptable skills.
- **Traditional competencies** are insufficient; new skills like data science and sustainability are essential.
- **Incremental changes have failed**; systemic transformation is needed.
- **Student expectations and competition** demand educational excellence.

Key Recommendations

1. **Recognize Teaching Innovation**
   - Support evidence-based teaching and curriculum development.
   - Reward accessible learning environments and experiential learning.
   - Encourage educational research and partnerships.
2. **Expand Definitions of Scholarship**
   - Include the Scholarship of Teaching and Learning (SoTL).
   - Value educational publications, grants, and modular curriculum development.
   - Link faculty contributions to student success metrics.
3. **Reward Access-Oriented Excellence**
   - Prioritize welcoming environments, mentoring, and community-building.
   - Recognize faculty efforts that support underserved students.
4. **Support Educational Leadership**
   - Acknowledge departmental change initiatives and curriculum innovation.
   - Credit strategic partnerships and leadership in faculty development.
   - Reward mentoring of junior faculty.
5. **Institutional Benefits**
   - Improved student recruitment, retention, and learning outcomes.
   - Increased faculty satisfaction and retention.
   - Stronger industry alignment and external funding opportunities.
   - Competitive advantage through innovation.
6. **Measuring Success**
   - Track metrics such as retention, learning outcomes, teaching effectiveness, and industry partnerships.
7. **Implementation Support**
   - Use case studies, assessment frameworks, and implementation strategies.
   - Align changes with faculty governance processes.

Career Framework for University Teaching

- Proposes a structured pathway for academic career progression based on teaching contributions.
- Encourages institutions to support, evaluate, and reward teaching excellence at all career stages.

Implementation Plan for Reimagining Institutional Policies

This topic presents a strategic, institution-wide implementation plan to **reform academic policies** in support of **teaching and learning innovation**. It emphasizes the need for a **holistic, accessible, and sustainable approach** to policy transformation that aligns with institutional goals and the evolving needs of society, students, and faculty.

Key Components of the Implementation Plan

- **Curriculum:** Enable modular, interdisciplinary, and competency-based learning.
- **Teaching Modalities:** Support hybrid, online, and experiential formats.
- **Assessment:** Prioritize authentic, formative, and student-centered evaluation.
- **Faculty Development:** Promote continuous pedagogical growth.
- **Technology Use:** Establish ethical and effective digital integration.
- **Collaboration:** Encourage cross-departmental and external partnerships.
- **Student Engagement:** Empower students as co-creators of their education.

This implementation plan provides a **comprehensive roadmap** for institutions to **systematically reform policies** that support innovation in teaching and learning. It calls for **institutional commitment, collaborative leadership, and long-term investment** to build a culture of continuous improvement and educational excellence.

Advocating for Financial Aid Flexibility

The *Mindset Report* calls for institutions to collaborate with federal and state governments to reform financial aid policies, ensuring they better support the varied and evolving needs of today's learners—particularly in engineering education.

Why Financial Aid Flexibility Matters

Traditional financial aid systems are designed for full-time, semester-based students, which excludes many modern learners such as:

- Part-time students
- Adult learners
- Students in co-ops, internships, or modular programs
- Those pursuing year-round or competency-based education

Reforming financial aid policies to be more flexible and accessible will:

- Increase access and affordability
- Support various learning pathways
- Align aid systems with the future of higher education

Modernizing Engineering Education

This topic presents a strategic roadmap to transform engineering education into a more accessible, adaptive, and outcomes-driven system. It emphasizes the need for institutions to evolve in response to technological change, workforce demands, and the imperative to serve a broader, more balanced student population. To embed a new engineering mindset—centered on curiosity, creativity, resilience, and ethical responsibility—into institutional culture, curriculum, and policy, while fostering a culture of accountability in access and representation.

This roadmap calls for a comprehensive, systemic transformation of engineering education—one that is equitable, student-centered, and aligned with the demands of a rapidly changing world. Institutions must commit to sustained innovation, accountability, and collaboration to ensure long-term success.

A New Ranking System for Engineering Education

This topic proposes a transformative collaboration between the **National Science Foundation (NSF)**, **American Society for Engineering Education (ASEE)**, and the **National Academy of Engineering (NAE)** to develop a new **ranking system for engineering programs**. Unlike traditional rankings, this system would prioritize **access, equity, and student success,** particularly for **underserved and first-generation students.**

Key Objectives

- **Shift focus** from prestige-based metrics to accessible, outcomes-driven criteria.
- **Recognize institutions** that excel in supporting underserved student populations.
- **Promote accountability** and transparency in engineering education.

Track Data That Matters

To support this ranking system, institutions must:

- Collect and disaggregate data on admissions, retention, graduation, academic performance, and post-graduation outcomes.
- Track metrics by race/ethnicity, socioeconomic status, first-generation status, gender, disability, veteran status, and more.
- Use data visualization and narrative context to interpret and communicate findings.
- Benchmark against peer institutions and national averages.

Implementation Strategy

- Institutions submit standardized annual reports.
- Data is verified through audits and third-party checks.
- Rankings are published annually with full transparency.
- Separate rankings are provided by institution type and demographic group.

Impact and Significance

This ranking system:

- **Elevates institutions** that prioritize equity and student success.
- **Encourages data-driven improvements** in access and support.
- **Provides students and families** with meaningful insights into institutional performance.
- **Aligns with national goals** for increased enrollment and an innovative engineering workforce.

Reimagining Registration and Admissions Systems

This topic outlines a strategic vision for transforming registrar and admissions systems to align with the evolving demands of engineering education. As institutions strive to become more accessible, flexible, and student-centered, these foundational systems must be modernized to support varied learning pathways and holistic student success.

Key Objectives

- **Modernize registrar and admissions systems** to support flexible, accessible, and data-informed education.
- **Align administrative processes** with the Engineering Mindset Report's call for innovation, equity, and adaptability.
- **Enhance student experience** through personalized, streamlined, and supportive systems.

Admissions Transformation

To support this ranking system, institutions must:

- Move beyond standardized test scores to **holistic admissions**.
- Evaluate applicants using:
  - Problem-solving assessments
  - Portfolios and personal statements
  - Interviews and creativity tests
  - Extracurricular involvement and competitions
- Focus on identifying **potential, creativity, and resilience,** especially in students from under-resourced K–12 backgrounds.

Registrar System Modernization

- Implement **flexible registration systems** that support:
  - Modular, interdisciplinary, and online learning
  - Credit for prior learning and alternative prerequisites
  - Personalized academic advising using AI and data analytics
- Enhance **student information systems** to track:
  - Competency-based progress
  - Transfer credits and multiple pathways
  - Success metrics

Key Functional Areas for Registrar Innovation

1. **Flexible Pathways**
   - Multiple entry points, transfer improvements, modular registration
2. **Course Scheduling Innovations**
   - Shorter modules, hybrid delivery, variable credits
3. **Transfer Student Support**
   - Streamlined articulation, credit evaluation, and success tracking
4. **Assessment Systems**
   - Competency-based grading, flexible timelines, and mastery documentation
5. **Data Collection & Reporting**
   - Track progression, time to degree, and completion pathways

Leveraging Strategic Partnerships

This topic section emphasizes the critical need for **broad, strategic partnerships** to drive systemic transformation in engineering education. Recognizing that no single group can enact change alone, the report calls for a **"network of networks"** approach to unite stakeholders across academia, industry, government, and community sectors. Strategic partnerships are essential to achieving the vision of accessible, future-ready engineering education. By building a coordinated ecosystem of stakeholders, institutions can drive meaningful, systemic change that aligns with societal needs and technological advancement.

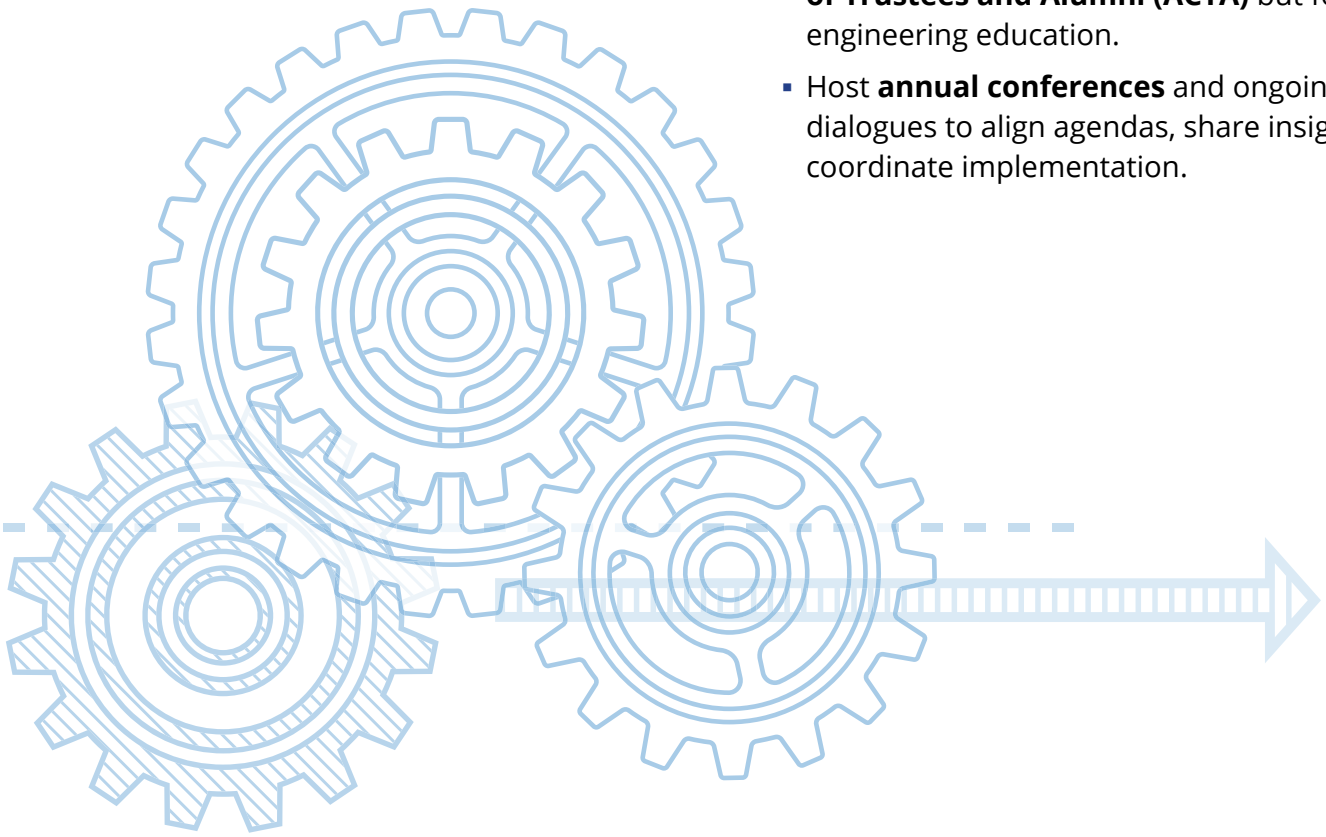
The Mindset Report calls for fostering partnerships among accreditation agencies, academia, and industry councils that focus on engineering in a societal context.

Why Partnerships Matter

- Engineering education is a **complex, distributed system** with many interdependent stakeholders.
- Incremental changes by educators alone are insufficient; **collaborative, systemic efforts** are required.
- A new model is needed to **coordinate and align efforts** across various groups.

Proposed Strategy: A "Network of Networks"

- Create a **central coordinating body** to connect and align adjacent networks (e.g., deans, ABET, registrars, enrollment managers).
- Model this body after successful forums like the **World Economic Forum or American Council of Trustees and Alumni (ACTA)** but focused on engineering education.
- Host **annual conferences** and ongoing dialogues to align agendas, share insights, and coordinate implementation.



Engaging with ABET to Support Curricular Innovation

This topic outlines a strategic approach to transforming the relationship between engineering programs and ABET (Accreditation Board for Engineering and Technology) to foster innovation, access, and adaptability in engineering education. It, and adaptability in engineering education. It emphasizes the need for collaborative reform of accreditation standards and processes to align with the evolving demands of society and the engineering profession.

The *Mindset Report* calls for the following:

Revising Accreditation Requirements

- Collaborate with ABET, industry, and academic leaders to modernize accreditation criteria.
- Promote a culture of innovation and reduce fear of non-compliance among institutions.
- Update definitions of "college-level mathematics" and "basic science" to reflect real-world engineering needs, including social sciences and applied math.
- Encourage transparency, faculty engagement, and accessible participation in ABET processes.
- Propose an ABET "Tiger Team" to support innovative programs during accreditation preparation.

Addressing the Divide Between Engineering and Engineering Technology

- Facilitate dialogue among ABET, NSPE, and academic institutions to reduce artificial barriers between engineering and engineering technology programs.
- Recognize overlapping competencies and reduce siloing in accreditation and licensure.
- Promote competency-based models and flexible degree pathways.

Creating a New Accreditation Option for BS Engineering Technology

- Propose a distinct accreditation track for BS engineering technology programs, separate from technician-focused programs.
- Alternatively, revise EAC criteria to include BS engineering technology programs by adjusting math/science requirements and outcome language.
- Ensure alignment with industry needs and reduce barriers to licensure and employment.

Impact

- Encourages risk-taking and innovation in curriculum design.
- Reduces inequities in access to engineering degrees and careers.
- Aligns accreditation with 21st-century engineering challenges and workforce needs.
- Enhances the credibility and relevance of engineering technology programs.

NSF Support for the Engineering Mindset Initiative

This topic outlines a bold vision for how the **National Science Foundation (NSF)** can catalyze systemic transformation in engineering education by supporting the implementation of the *Engineering Mindset Report*. It proposes two major national programs—**FUEL and TREES**—to drive innovation, equity, and excellence in engineering education across the United States.

- The *Mindset Report* calls for a reimagined engineering education system that emphasizes creativity, ethical responsibility, resilience, access and success.
- NSF is uniquely positioned to lead this transformation through targeted investments and national coordination.
- Regional alliances, as highlighted in the 2024 Singer et al. report, are proven models for scalable, community-driven educational reform.

Proposed NSF Programs

1. **FUEL – Fostering Undergraduate Engineering Learning**
   - A new NSF initiative to support up to 10 regional innovation hubs.
   - Modeled after NSF's ERC and Regional Innovation Engines programs.
   - Each FUEL site will include:
     - Universities, national labs, industry, PK–12 schools, nonprofits, and government agencies.
   - Goals:
     - Advance innovative undergraduate engineering and engineering technology education.
     - Promote access, and high-impact learning.
     - Stimulate regional economic growth and workforce development.
2. **TREES – Transforming and Re-engineering the Engineering Education System**
   - A proposed Engineering Research Center (ERC) focused on systemic educational reform.
   - Research Thrusts:
     - **RT1:** Affordability and Accessible
     - **RT2:** Pedagogy and Content for 21st Century Challenges
     - **RT3:** Propagation of Educational Innovations
   - Objectives:
     - Address systemic barriers like the "weed-out" culture and overreliance on calculus.
     - Promote student-centered, accessible, and socially responsive engineering education.
     - Conduct longitudinal studies to identify and scale effective practices.

The proposed FUEL and TREES programs represent a **national call to action**. With NSF leadership, these initiatives can:

- Drive **systemic, scalable, and sustainable change**.
- Empower a **dynamic new generation of engineers**.
- Align engineering education with the **complex needs of society and industry.**

Transforming engineering education is not just a strategic opportunity—it is a **national imperative**.

Collaborating with Colleges of Liberal Arts

This topic advocates for the integration of liberal arts into undergraduate engineering education to produce engineers who are not only technically skilled but also socially conscious, ethically grounded, and culturally aware. It outlines the benefits, strategies, and successful models for fostering interdisciplinary collaboration between engineering and liberal arts programs.

Key Benefits of Integrating Liberal Arts into Engineering

1. **Enhanced Communication Skills**
   - Improves writing, speaking, and critical reading—essential for leadership and collaboration.
2. **Broader Ethical and Social Awareness**
   - Encourages reflection on the societal and environmental impacts of engineering decisions.
3. **Improved Critical Thinking and Problem-Solving**
   - Promotes creative, multi-perspective analysis and innovation.
4. **Greater Adaptability and Lifelong Learning**
   - Prepares students for interdisciplinary work and evolving career landscapes.
5. **Stronger Leadership and Teamwork Abilities**
   - Builds understanding of human behavior and organizational dynamics.
6. **Increased Empathy and User-Centered Design**
   - Supports the development of accessible, human-centered technologies.

Strategies for Integration

- **Interdisciplinary Courses:** Engineering ethics, societal impacts of technology.
- **Collaborative Projects:** Real-world, socially relevant projects involving both engineering and liberal arts students.
- **Integrated Curriculum:** Courses combining technical and liberal arts content, including writing and communication training.
- **Institutional Support:** Faculty collaboration, shared resources, and support networks.
- **Cultural and Historical Context:** Courses on the cultural history of engineering and public debates on technology.

Successful Models

- **Lafayette College:** A.B. in Engineering Studies bridges engineering and liberal arts.
- **Harvey Mudd College:** Liberal arts college with a strong engineering core.
- **Purdue University – Cornerstone Program:**
  - Offers a 15-credit certificate focused on transformative texts and interdisciplinary learning.
  - Enhances communication, critical thinking, and cultural awareness.
  - Recognized nationally and replicated by over 70 institutions.

Integrating liberal arts into engineering education equips students with the skills and mindset needed to address complex societal challenges. Programs like Purdue's Cornerstone demonstrate how interdisciplinary collaboration can enrich the engineering curriculum, foster leadership, and prepare students for a dynamic, interconnected world.

Community Colleges and Engineering Program Collaboration

This topic emphasizes the critical role of **strategic partnerships between community colleges and engineering programs** in expanding access, improving student success, and diversifying the engineering workforce. Community colleges serve as accessible entry points for many students, and aligning their efforts with four-year engineering institutions can create seamless, supportive pathways to engineering degrees.

Key Challenges

- Transfer rates from community colleges to four-year institutions remain low.
- The traditional "2+2" model is often ineffective due to:
  - Misaligned curricula
  - Institutional resistance
  - Lack of shared accountability
  - Confusing credit transfer policies
- These issues disproportionately affect low-income and underserved students.

Improving transfer pathways between community colleges and engineering programs is essential for building a more accessible, efficient, and equitable engineering education system. Through coordinated policy, institutional collaboration, and student-centered support, these partnerships can unlock opportunities for thousands of aspiring engineers.

Aligning K–12 and Engineering Education

This topic presents a comprehensive strategy to integrate engineering into PK–12 education, aiming to build a dynamic, balanced, and well-prepared pipeline of future engineers. It emphasizes the need for systemic change, early exposure, and strategic partnerships to ensure engineering becomes a foundational component of every student's educational journey.

Foster broad collaborations to assist PK–12 educational systems in valuing and championing engineering learning.

Key Challenges

- Engineering is often treated as an elective or add-on in K–12, limiting access—especially for underserved students.
- Exposure to engineering varies widely by ZIP code and income.
- There is a lack of clarity and consistency in defining engineering as a discipline in K–12 education.

Strategic Solutions

1. Define Engineering as a Core Discipline
   - Clearly communicate engineering's identity, distinct from general STEM.
   - Promote engineering literacy, career awareness, and technical achievement.
2. Use the Framework for P–12 Engineering Learning
   - Developed by ASEE, this framework outlines:
     - Engineering habits of mind (e.g., creativity, persistence).
     - Engineering practices (e.g., design, analysis).
     - Engineering knowledge domains (e.g., math, science, applications).
   - Scaffolds learning from K–5 through high school to prepare students for postsecondary pathways.
3. Project Lead The Way (PLTW) as a Scalable Model
   - PLTW serves over 2.3 million students across PreK–12 in engineering, biomedical science, and computer science.
   - Uses an Activity-Project-Problem (APB) learning model.
   - Offers robust teacher training and industry-aligned curriculum.
   - Provides a strong foundation for collaboration between K–12 and higher education.

To build a dynamic and future-ready engineering workforce, engineering must be embedded in PK–12 education. Through systemic reform, strategic partnerships, and scalable models like PLTW, the engineering community can ensure that all students—regardless of background—have the opportunity to explore, engage with, and pursue engineering careers.

Industry's Role in Advancing Engineering Education

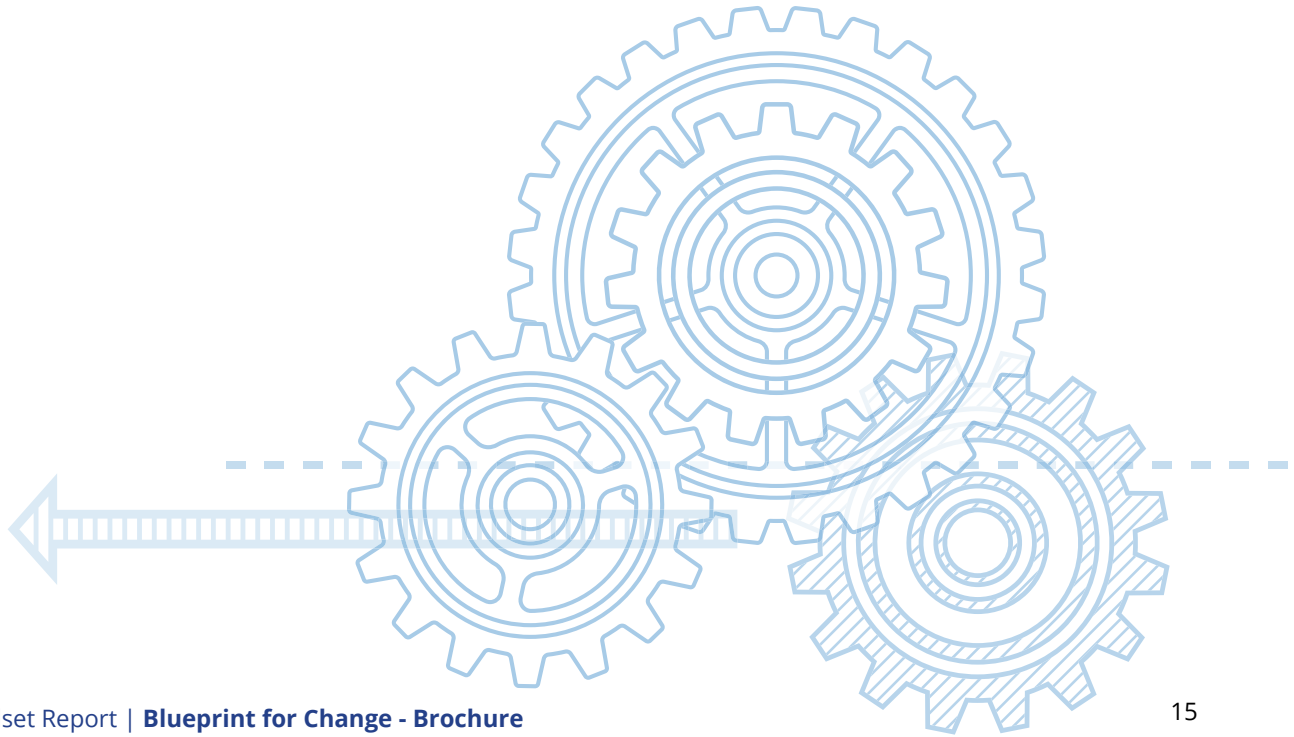
This section emphasizes the critical role of **industry-academia collaboration** in implementing the *Engineering Mindset Report* and preparing a balanced, innovative, and workforce-ready generation of engineers. Industry engagement is essential to bridge the gap between theoretical education and real-world application, ensuring engineering graduates are equipped to meet evolving societal and technological challenges.

Why Industry Engagement Matters

- Bridges Theory and Practice: Industry involvement contextualizes academic learning through real-world applications.
- Enhances Employability: Internships, co-ops, and mentorships provide students with practical experience and career readiness.
- Drives Innovation: Collaboration fosters the development of new technologies and solutions.
- Ensures Curriculum Relevance: Industry input helps align academic programs with current and future workforce needs.
- Provides Resources: Financial support, equipment, and access to cutting-edge tools improve the quality of education.
- Builds Networks: Partnerships help students develop professional connections and mentorship opportunities.

Call to Action

- Industry must make collaboration with engineering programs a **strategic priority**.
- Engineering programs should proactively engage with **regional and national industry partners**.
- Professional societies and industry groups should align with the *Mindset Report* and *Blueprint for Change* to support access and innovation in engineering education.



National Academy of Engineering: Convergence of Insights in Engineering Education

This section explores the alignment between the **ASEE's *Engineering Mindset Report* (2024)** and over two decades of **National Academies of Sciences, Engineering, and Medicine (NASEM)** publications. It highlights shared priorities, persistent challenges, and opportunities for synergistic action to transform undergraduate engineering and engineering technology education.

- The National Academies and ASEE have a long history of advancing engineering education reform.
- Landmark reports like *The Engineer of 2020* and *Educating the Engineer of 2020* laid the foundation for many of the recommendations in the *Engineering Mindset Report*.

Areas of Alignment Between ASEE and NASEM

Flexible Program Structures

- Emphasis on modular curricula, contextualized math, competency-based assessment, and seamless transitions between engineering and engineering technology programs.
- Supported by reports such as *Enhancing the Community College Pathway to Engineering Careers* and *Engineering Curricula: Understanding the Design Space*.

Evidence-Based, Student-Centered Pedagogy

- Recommendations include hands-on learning, student-centered assessment, faculty development, and digital platforms.
- Reinforced by *Science and Engineering for Grades 6–12*, *Infusing Advanced Manufacturing into Undergraduate Engineering Education*, and others.

Learning Environments

- Focus on evaluating systemic barriers, faculty training in equity, and socio-technical curriculum reform.
- Echoed in *Surmounting the Barriers*, *Building Capacity for Teaching Engineering in K-12 Education*, and *Lifelong Learning Imperative in Engineering*.

Institutional Transformation

- Calls for revising tenure and promotion, accreditation, financial aid, and data tracking.
- Supported by *Developing Metrics for Assessing Engineering Instruction*, *Forum on Proposed Revisions to ABET Criteria*, and *Connecting Efforts to Support Minorities in Engineering Education*.

Strategic Partnerships

- Emphasizes experiential learning, industry-academia collaboration, and bridging engineering and engineering technology.
- Aligned with *Infusing Real World Experiences into Engineering Education* and *Engineering Technology Education in the United States*.

K–12 Engineering Education

- Advocates for early exposure, teacher training, and systemic support.
- Reinforced by *Engineering in K-12 Education*, *Standards for K-12 Engineering Education*, and *Building Capacity for Teaching Engineering in K-12 Education*.

Changing Perceptions and Removing Barriers

- Reframes engineering as creative and accessible, not just math-intensive.
- Supports flexible, student-centered pathways into the profession.
- Reflected in *Educating the Engineer of 2020* and *Engineering Technology Education in the United States*.

The Engineering Mindset Report and NASEM publications share a unified vision: to create a more accessible, flexible, and impactful engineering education system. Their convergence offers a roadmap for systemic reform, grounded in decades of research and practice. Moving forward, coordinated dissemination and implementation of these aligned recommendations can catalyze meaningful change across the engineering education landscape.

Engineering Mindset
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