Engineering Education Review

REVIEW

The National Academy of Engineering and engineering professional societies

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ABSTRACT

The National Academy of Engineering (NAE), one of the three academies operating under the National Academies of Sciences, Engineering, and Medicine, plays a pivotal role in advising the federal government on engineering and technology-related matters. Created under the same 1863 congressional charter that established the National Academy of Sciences (NAS), the NAE convenes experts from diverse backgrounds to provide consensus-driven guidance on pressing national issues. This paper presents an overview of the NAE's structure, membership, and study processes, highlighting its unique contributions. Most NAE members belong to one or more engineering professional societies (EPS); the relationship of NAE to these societies is reviewed. The purpose of this paper is to illuminate opportunities for collaborations between EPS and the NAE and demonstrate a high degree of existing collaboration between EPS members and the NAE. While election to the NAE is a significant honor for an engineer, the NAE exists primarily as a service organization, providing advice to the government and conducting scientific and practical studies. The process for election to the NAE is discussed. The study processes of National Academies of Sciences, Engineering, and Medicine (NASEM) are reviewed, with examples including impactful work in safety reform following the Deepwater Horizon disaster, guiding National Aeronautics and Space Administration (NASA)'s repair of the Hubble telescope, and the development of fuel economy standards. The NAE's commitment to a variety of memberships across academia, industry, government, and non-profits (GNP) organizations, as well as its emphasis on leadership, innovation, and societal impact, are discussed in detail. The paper discusses how engineers can contribute more actively to NAE's mission.

Key words: professionalism, ethics, national academy, professional society, engineering leadership, honorary organizations

INTRODUCTION

The National Academy of Engineering (NAE) was established in 1964 under the congressional charter granted to the National Academy of Sciences (NAS) in 1863, signed into law by President Abraham Lincoln (Cochrane, 1978; National Academies of Sciences, Engineering, and Medicine, 2025). A painting by Albert Herter commemorates this founding in an apocryphal scene depicting Lincoln at the signing of the Academy charter, surrounded by leading scientific figures of the time who served as founders and Massachusetts Senator Henry Wilson (to Lincoln's right), who introduced the bill establishing the Academy and would become the 18th Vice President of the United States (Figure 1). Approximately half of the founding members of the NAS would today be recognized as engineers. The NAE shares this charter with the NAS and the National Academy of Medicine (NAM), and together they operate as the National Academies of Sciences, Engineering, and Medicine (NASEM). Under this unified structure, NASEM provides independent, evidence-based advice to the federal government on a wide range of scientific, engineering, and medical issues.

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The National Research Council (NRC), an operational arm of NASEM, was temporarily established in 1916 to help the NAS fulfill its mission of advising the nation on science and technology. President Woodrow Wilson issued an Executive Order in 1918 to establish the NRC as a permanent organization. The NRC's primary function is to provide independent, objective studies and analyses to inform policy and address complex societal issues. The term NRC is no longer used externally; for clarity, these studies are performed by NASEM, otherwise known as the National Academies. The NAE's mission is to advance the welfare and prosperity of the nation by providing independent advice on matters involving engineering and technology and promoting a vibrant engineering profession and public appreciation of engineering. Its vision extends to building a healthier, more secure, and more sustainable world through the application of engineering expertise. Engineering professional societies include professional organizations that primarily serve their membership, along with the public (Meehan, 2015a), standards organizations which develop, promulgate, and maintain technical standards for products and services, and service and honorary organizations. The NAE is focused on national service and impact through consensus-driven advice and public engagement.

In 2025, the NAE elected 128 new members and 22 international members, bringing the total U.S. membership to 2, 474 and the international membership to 336. Members pay annual dues or lifetime dues. The NAE is not an agency of the federal government but a private, independent, nonprofit institution. It advises the federal government and conducts independent studies that examine important topics in engineering and technology. NAE is not a grant-making institution.

BACKGROUND

NAE has been shaped by the traditions and structures of earlier national academies, particularly those in Europe. Notably, the Royal Society of London, established in 1660, and the Académie des Sciences in Paris, founded in 1666, served as early models for scientific advisory bodies. These institutions demonstrated the value of bringing together leading minds to provide independent guidance on scientific and technological matters. Their enduring legacies influenced the formation of the U.S. NAS in 1863, which later led to the establishment of the NAE in 1964 to address engineering challenges specifically.

The architectural and artistic elements of the NAS building in Washington, D.C., further reflect this international heritage. Designed by architect Bertram Grosvenor Goodhue and completed in 1924, the building's Great Hall features a dome adorned with artwork by Hildreth Meière (Library of & Highsmith, 2025). The dome's iconography includes allegorical representations of the eight fundamental scientific disciplines as understood in the early 20th century: Physics, Astronomy, Chemistry, Geology, Anthropology, Zoology, Botany, and Mathematics. Surrounding these are depictions of historical scientific institutions, including the Royal Society of London, the Académie des Sciences in Paris, the Accademia dei Lincei in Rome, and the ancient Museum of Alexandria.

Figure 1. Founders of the National Academy of Sciences (Albert Herter).

The seal of each of what Meière titled the *Ancient Academies of Science* (Library of & Highsmith, 2025) is shown on the soffits (National Academies of Sciences, Engineering, and Medicine, 2025) along with example achievements of scientists from those nations. For example, for the Accademia dei Lincei, Meière portrayed Alessandro Volta's electric pile battery alongside Galileo Galilei's telescope. For the Royal Society of London, she illustrated Isaac Newton's prism and James Watt's steam engine. The panel for the Académie des Sciences in Paris features Louis Daguerre's camera and the flask Blaise Pascal used to demonstrate the weight of air. For the ancient Museum of Alexandria, she included imagery of the pyramids and the Lighthouse of Alexandria. The iconography of the dome is titled the History of Science as Known in 1922. The inscription on the dome reads: "To Science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of nature's laws, eternal guide to truth." These artistic choices underscore and acknowledge the roots of a global scientific tradition.

The pendentives (Cochrane, 1978) of the dome (Figure 2) feature allegorical figures representing the four classical elements: Earth, Air, Fire, and Water. Each element is accompanied by symbols of human inventions that utilize that element, such as a plowshare for Earth and a sailboat for Air. This integration of art and science within the building's design serves not only as a tribute to the history of scientific inquiry but also as an inspiration for ongoing exploration and discovery.

Figure 2. Artistic detail of pendentive showing "Earth".[6]

Figure 3. Albert Einstein memorial at the national academies building.

The Albert Einstein Memorial (Figure 3) is a monumental bronze statue located on the grounds of the NAS in Washington, D. C. Unveiled on April 22, 1979, to commemorate the centennial of Einstein's birth, the statue was created by sculptor Robert Berks. It portrays Einstein seated in a relaxed pose, holding a manuscript inscribed with three of his most significant equations: the theory of general relativity, the photoelectric effect, and the equivalence of mass and energy ($E = mc^2$). The statue rests on a three-step bench made of white granite, and the surrounding circular plaza features over 2, 700 metal studs representing celestial objects as they appeared at noon on the day of the memorial's dedication. This interactive feature allows visitors to engage with the monument, which has become a popular spot for tourists and science enthusiasts alike. A second statue of Einstein, also by Robert Berks and modeled after the Washington, D. C. original, is located at the Georgia Institute of Technology and serves as a focal point for its School of Physics.

ORGANIZATIONAL STRUCTURE AND STUDY PROCESS

The NAE operates within NASEM as a self-governing body, working in concert with NAS and NAM to conduct studies, workshops, and convening activities. NASEM studies are initiated by requests from federal or state agencies, Congress, or foundations and are conducted by committees composed of independent experts selected for their knowledge and perspectives. These experts do not have to be members of one of the academies and serve as unpaid volunteers. These studies follow a rigorous process to ensure balance, objectivity, and transparency. Committees conduct literature reviews, public meetings, and deliberative sessions to develop consensus findings and recommendations. All reports undergo an extensive independent peer-review process before release. Groups that fund such studies do not have editorial or review capabilities for the reports issued. The National Academies have recently announced the reorganization of how they conduct most of their work from seven to four major program areas, as follows: (1) Center for Health, People, & Places (CHPP), (2) Center for Advancing Science & Technology (CAST), (3) Transportation Research Board (TRB), (4) Gulf Research Program (GRP). Both of the Centers have six program areas, allowing the National Academies to work on a broad range of issues designed to encourage collaboration. In addition, three new offices were established to consolidate institution-wide activities and strategic-planning priorities: the Office of International Networks, Cooperation, and Security; the Office of Strategy and Engagement; and the Office of Fellowships.

The NAE participates in joint studies with NAS and NAM and leads engineering-specific initiatives. Notable examples include reports on energy systems, engineering education, engineering ethics, resilience, and infrastructure. Studies range from major consensus reports to rapid expert consultations and other products that do not generate recommendations. For example, the GRP, established following the Deepwater Horizon (Cochrane, 1978; Meehan, 2015a; Meehan, 2015b; National Academies of Sciences, Engineering, and Medicine, 2025; Transportation Research, 2016) disaster exemplifies the NAE's long-term commitment to improving safety and resilience in offshore energy operations. Consensus studies are the gold standard for Academy studies because they embody the National Academies' commitment to independence, objectivity, and scientific rigor. This credibility stems from a meticulous process that includes carefully defining the scope of work, selecting expert committees with balanced perspectives, conducting transparent information gathering, and undergoing a rigorous independent review. These checks and balances ensure that the resulting reports are trusted, evidence-based, and free from outside influence, earning the confidence of policy-makers, researchers, and the public.

NAE members and international members may take positions in their personal capacity and use their NAE affiliation. They may not present themselves as representing the NAE nor represent any position not stated in an NAE/NASEM document as being that of the NAE without explicit prior approval of the NAE president, or in his/her absence the executive officer.

A few examples of highly cited and downloaded studies of interest include: Construction and rehabilitation of concrete pavements under traffic (National Academies of Sciences, Engineering, and Medicine, 2018); On being a scientist: A guide to responsible conduct in research (Third Edition); STEM integration in K-12 education: Status, prospects, and an agenda for research (Honey *et al.*, 2014); Genetically engineered crops: Experiences and prospects (National Academies of Sciences, Engineering, and Medicine, 2016b); Negative emissions technologies and reliable sequestration: A research agenda (National Academies of Sciences, Engineering, and Medicine, 2019); Nutrient requirements of dairy cattle: Seventh revised edition, 2001 (National Research Council, 2001); Prudent practices in the laboratory: Handling and management of chemical hazards (Updated version) (National Research Council, 2011); Attribution of extreme weather events in the context of climate change (National Academies of Sciences, Engineering, and Medicine, 2016a); Quantum computing: progress and prospects (Grumbling & Horowitz, 2019); Pathways to discovery in astronomy and astrophysics for the 2020s (National Academies of Sciences, Engineering, and Medicine, 2020); Reproducibility and replicability in science (Committee on Reproducibility and Replicability in Science *et al.*, 2019); and Modernizing probable maximum precipitation estimation.

The last study on the list can serve as an example of the process. Probable maximum precipitation (PMP) estimates are crucial for engineers when designing large, critical facilities like dams and nuclear power plants, as they help determine the "worst-case scenario" precipitation for the area. This ensures that the facility can withstand maximum precipitation, reducing the risk of catastrophic events. The bipartisan Infrastructure Bill and the Precipitation Act (PRECIP) outline a specific process for PMP modernization by the National Oceanic and Atmospheric Administration (NOAA) starting with a study by the NASEM to recommend the best scientific approach. NOAA's sponsorship of this study, authorized by the PRECIP Act, establishes a committee of experts to author a consensus study on estimating PMP in a changing climate, aiming to recommend an updated approach suitable for decision-makers' needs.

NAE is governed by a council consisting of a chair, president, vice president, home secretary, international secretary, treasurer, executive officer, and twelve councilors, all elected by the NAE membership. The NAE employs a staff of approximately 35 individuals and operates with a budget of $15.8 million for the year 2025. Philanthropic sources contribute 60% of the total revenue, while dues and registration fees account for only 4%. The remaining funds are derived from the NAE's collaboration with the NRC and direct billing of staff time for special projects (National Academies of Sciences, 2025).

MEMBERSHIP IN THE NAE

Election to the NAE is one of the highest professional honors an engineer can receive. Members are selected based on outstanding personal contributions and accomplishments in at least one of three areas (National Academies of Sciences, Engineering, and Medicine, 2025): engineering practice, research, or education(Cochrane, 1978); pioneering new and developing fields of technology or advancing traditional fields; or leadership of major engineering endeavors (Meehan, 2015a). Additional consideration is given to service to the profession and the public, though service alone is not a sufficient criterion for election. Members are elected by their peers, who are current NAE members. Many members have received the highest awards of their respective professional societies but this is not required.

The nomination process is confidential, and nominees are not informed of their status or even if they have been nominated. Thus, individuals cannot apply for membership in the NAE; self-nomination is not possible and solicitation of nomination is considered inappropriate. International members—non-U. S. citizens or permanent residents—may also be elected and may become regular members upon acquiring U. S. citizenship unless they choose otherwise. NAE membership is intentionally diverse in terms of technical discipline and work sector. Members are drawn from academia, industry, government, and the non-profit sector. This work sector balance distinguishes the NAE from its sister academy, the NAS, which is predominantly academic. The inclusion of business leaders ensures the NAE's relevance to practical engineering applications and innovation. Approximately half of its members are affiliated with business organizations. This balance reflects the recognition that engineering innovations are most impactful when implemented in the real world. Government, and non-profits (GNP) representation is also encouraged, with attention to leaders who have shaped public policy, regulation, and large-scale projects. This sectoral diversity enables the NAE to offer comprehensive advice that bridges theory and practice. It also ensures that recommendations are informed by practical constraints and implementation pathways. The deliberate inclusion of varied perspectives enhances the legitimacy and applicability of NAE reports and workshops.

Members are organized into twelve disciplinary sections, which guide nominations and review processes. The sections, numbered 1-12 include Aerospace Engineering (Section 1); Bioengineering (Section 2); Chemical Engineering (Section 3); Civil Engineering (Section 4); Computer Science and Engineering (Section 5); Electric Power/Energy Systems Engineering (Section 6); Electronics, Communication & Information Systems Engineering (Section 7); Industrial, Manufacturing & Operational Systems Engineering (Section 8); Materials Engineering (Section 9); Mechanical Engineering (Section 10); Natural Resources Engineering (Section 11); and Special Fields and Interdisciplinary Engineering (Section 12). Some members also belong to a secondary section when their work significantly overlaps section boundaries.

Each member is elected with an election citation. The election citation plays an important role in the nomination and election processes for membership in the National Academies. This concise statement of 20 words or less succinctly encapsulates the nominee's most significant contributions to their field. It serves as a formal acknowledgment of the nominee's distinguished and ongoing achievements in original research or outstanding contributions to engineering research, practice, or education.

Beyond its role in the election process, the citation is also used in official announcements and member directories to highlight specific accomplishments for which the individual was honored. This ensures that the recognition is both precise and publicly accessible, underscoring the individual's impact on their respective field. For example, the citation for the late Dr. Fazlur Rahman Khan is "*Innovations in the design and construction of tall buildings of steel and reinforced concrete.*" Elbert Rutan's citation is "*For leading the engineering design, construction, and testing of a series of remarkable aircraft, including the Voyager, the first unrefueled aircraft to circle the earth.*" The late Jack S. Kilby was honored for "*Inventions basic to integrated circuits.*"

PROGRAMS AND STRATEGIC FOCUS AREAS

The NAE engages in a variety of programs to advance its mission. The Grand Challenges for Engineering was launched in 2008 and galvanized international attention to major societal challenges where engineering can make a difference, such as providing access to clean water, securing cyberspace, and making solar energy economical. These challenges have been adopted by universities and institutions around the world (Meehan, 2016).

Pathways into Engineering is an NAE initiative dedicated to informing, inspiring, and creating opportunities for K-12 youth and their caregivers to learn about and engage with engineering. Working in close partnership with educators, communities, and families, Pathways emphasizes the societal impact of engineering and encourages youth to envision themselves in engineering careers. As the U. S. faces a projected need for 400, 000 new engineers annually (Kodey *et al.*, 2023) and a 7.6% growth in engineering-related jobs through 2033, it is vital that the future engineering workforce reflects the diversity of the nation (Figure 4). Increased participation strengthens innovation and decision-making around technological and societal challenges.

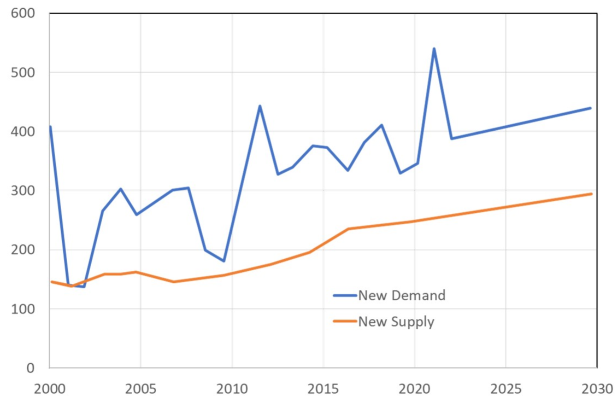

Figure 4. New engineer supply and demand, sources U.S. Bureau of labor statistics, National Science Foundation, American Society of Engineering Education, US Citizen and Immigration Services, Boston Consulting Group analysis (Kodey *et al.*, 2023).

Serving as a hub for outreach programs that promote inclusive engagement, *Pathways into Engineering* supports signature efforts such as the internationally recognized *EngineerGirl* program, which has promoted interest in engineering among middle and high school girls since its launch in 2001. Its companion site, *EngineerTeen*, inspires all teens aged 13–18 as they explore the exciting world of engineering. These platforms host award-winning initiatives, including the annual writing contest, *Ask an Engineer*, and the *Engineering Ambassadors* program—each designed to connect youth from all backgrounds with engineering role models and experiences. Oversight of the initiative is provided by the Pathways into Engineering Steering Committee, composed of leaders from public and private institutions committed to advancing engineering education. The committee advises the NAE on program design and strategy, ensuring that outreach efforts are impactful, evidence-informed, and aligned with national workforce and education needs. Together, these efforts aim to build a vibrant, representative engineering community that is open to all and equipped to shape a better future.

The Grainger Foundation Frontiers of Engineering (FOE) symposia are dynamic gatherings that bring together emerging engineering leaders from industry, academia, and government laboratories to explore pioneering technical advances and cutting-edge research. Designed to foster cross-disciplinary exchange, these meetings aim to introduce outstanding early-career engineers to one another and to promote collaboration, the transfer of innovative techniques across fields, and the formation of lasting professional networks among the next generation of engineering leaders. The NAE solicits nominations from Chief Technology Officers, professors, NAE members, and heads of government labs and identifies winners of "early career" research and engineering awards from professional societies, the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and others to identify potential participants. The FOE portfolio includes five distinct meetings: the flagship Grainger FOE Symposium held annually in the United States, along with rotating international meetings in collaboration with Germany, Japan, China, and the European Union. Each symposium focuses on four technical topics that vary annually to reflect current and emerging areas of engineering. Past topics have included visualization for design and display, nanotechnology, advanced materials, robotics, additive manufacturing, energy and the environment, optics, autonomous vehicles, space technologies, design research, genomic engineering, cybersecurity of critical infrastructure, and quantum computing. The structure of the meetings encourages lively dialogue, with ample time dedicated to discussion following each presentation. Participants also benefit from breakout sessions, poster sessions, and informal events that provide additional opportunities for exchange and connection. A robust alumni program supports continued interaction and collaboration among participants. Attendees consistently find the FOE symposia to be uniquely valuable for bringing together a diverse group of engineers to engage with the forefront of engineering challenges and innovations across disciplines.

NAE seeks to promote engineering literacy among policymakers and the public. Its initiatives include partnerships with the media, STEM educators, and corporate sponsors. Through forums and roundtables, the NAE facilitates dialogue on topics like manufacturing innovation, energy systems, and infrastructure resilience.

The Forum on Complex Unifiable Systems (FOCUS) is a multistakeholder initiative aimed at enhancing the understanding and management of complex technical and social systems. It addresses issues in health, security, democracy, urbanization, infrastructure, research, education, economy, transportation, environment, modern work, and civic life. The forum publishes short-form perspectives to guide executive decision-making.

Cultural, Ethical, Social, and Environmental Responsibility in Engineering (CESER) aims to highlight the importance of ethical, cultural, social, and environmental considerations in engineering practice. It engages engineers, educators, industry leaders, professional societies, government entities, and the public. CESER produces publications based on its studies and workshops.

The NAE President's Business Advisory Committee (PBAC) offers guidance on engaging the business community in NAE activities and assessing the value of NAE to this sector. PBAC collaborates with the NAE president to enhance business engagement and representation within the academy, its advisory roles to the government and public, and interactions with business leaders. The NAE's substantial business membership distinguishes it from the other National Academies.

Practices for Engineering Education and Research (PEER) focuses on engineering education and related research at pre-college and higher education levels. It conducts studies, workshops, and activities guided by a strategic approach that considers the entire educational system and its contextual influences. PEER brings together researchers and practitioners in engineering education and publishes analyses to guide change.

The NAE Grand Challenges for Engineering identified a visionary set of 14 global goals. At the request of the NSF, the committee, a distinguished panel of leading engineers and scientists from around the world, aimed to highlight bold yet achievable and sustainable opportunities for engineering to improve life on Earth. Rather than prescribing specific solutions or ranking priorities, the panel selected challenges that address critical needs for people and the planet, such as clean water, cybersecurity, energy sustainability, and engineering better medicines. Their conclusions, reviewed by over 50 subject matter experts and enriched by input from the global public, have since inspired a broad array of educational programs and high-profile international events. While the NAE effort is completed, the initiative continues to galvanize new generations of engineers around a shared mission to tackle society's most pressing problems.

THE ROLE OF ENGINEERING PROFESSIONAL SOCIETIES

Engineering professional societies play a pivotal role in advancing the engineering field by fostering collaboration, disseminating knowledge, establishing industry standards, supporting professional development, and advocating for the profession's interests. These organizations offer engineers a platform to exchange innovative ideas, engage in lifelong learning, and build networks that contribute to both career advancement and societal progress. Some of the most prominent engineering professional societies include the American Institute of Aeronautics and Astronautics (AIAA) (American Institute of Aeronautics and Astronautics, 2025), the world's largest aerospace technical society; the Biomedical Engineering Society (BMES) (Biomedical Engineering Society, 2025), which supports education and research to improve human health; the American Institute of Chemical Engineers (AIChE) (American Institute of Chemical Engineers, 2025), a global organization focused on career development and continuing education for chemical engineers; and the American Society of Civil Engineers (ASCE) (American Society of Civil Engineers, 2025), which represents civil engineers worldwide. A 1985 NRC report (National Research Council, 1985) emphasizes the vital role professional societies play in continuing education by offering specialized training, certification programs, conferences, and publications that help engineers maintain competence throughout their careers. It also outlines how societies collaborate with industry and academia to identify skill gaps and support lifelong learning. Additional leading societies include the Association for Computing Machinery (ACM) (Association for Computing Machinery, 2025), dedicated to advancing computing; the Institute of Electrical and Electronics Engineers Power & Energy Society (IEEE PES) (Energy, 2025), focused on electric power and energy; the Institute of Electrical and Electronics Engineers (IEEE) (Institute of Electrical and Electronics Engineers, 2025), the world's largest technical professional organization; the Institute of Industrial and Systems Engineers (IISE) (Institute of Industrial and Systems Engineers, 2025); American Society of Materials (ASM) International (ASM International, 2025), which supports materials scientists and engineers; the American Society of Mechanical Engineers (ASME) (American Society of Mechanical Engineers, 2025); the Society of Petroleum Engineers (SPE) (Society of Petroleum Engineering, 2025); the Society for Mining, Metallurgy, and Exploration (SME) (Society for Mining, Metallurgy, and Exploration, 2025); the American Society of Agricultural and Biological Engineers (ASABE) (American Society of Agricultural and Biological Engineers, 2025) and American Geophysical Union (AGU) (American Geophysical Union, 2025). AGU was established in 1919 by the NRC and operated as an affiliate of the NAS until 1972. AGU has 60, 000 members in 137 countries, and many NAE members have served in leadership roles of AGU in atmospheric, hydrologic, oceanic, and space science (National Academies of Sciences, Engineering, and Medicine, 2024). The American Meteorological Society (AMS) (American Meteorological Society, 2025) advances the atmospheric and related sciences through research, education, and professional engagement, promoting the understanding and application of weather, water, and climate information for the benefit of society. Additional professional societies with significant NAE membership include the Society for Biomaterials (SFB) (Society for Biomaterials, 2025a), the American Chemical Society (ACS) (American Chemical Society, 2025), Materials Research Society (MRS) (Materials Research Society, 2025), Institute for Operations Research and the Management Sciences (INFORMS) (Institute for Operations Research and the Management Sciences, 2025), American Society for Quality (ASQ) (American Society for Quality, 2025), International Academy for Production Engineering (CIRP) (International Academy for Production Engineering, 2025), Society of Manufacturing Engineers (SME, not to be confused with Society for Mining, Metallurgy, and Exploration) (Society of Manufacturing Engineers, 2025); National Council of Structural Engineers Associations (NCSEA) (National Council of Structural Engineers Associations, 2025); Minerals, Metals, and Materials Society (TMS) (Minerals, Metals, and Materials Society, 2025) .

Beyond these major societies, hundreds of specialized and international organizations serve niche engineering communities. Trade associations primarily represent and advocate for the interests of companies within an industry, focusing on business, regulatory, and policy issues, whereas professional societies serve individual practitioners by promoting technical excellence, professional development, and ethical standards within a discipline. Examples of large trade associations include the American Hospital Association, the American Petroleum Institute, the American Bar Association. Trade associations often have significant lobbying efforts in support of their respective industry's interests; lobbying is uncommon for professional associations.

Engineering honor and service societies also contribute to public service and professional recognition. Tau Beta Pi (TBP) (Tau Beta Pi, 2025), the oldest U. S. engineering honor society, celebrates academic excellence and exemplary character. The Order of the Engineer instills ethical responsibility through the Engineer's Oath

(Order of the Engineer, 2025). The Society of Women Engineers (SWE) (Society of Women Engineers, 2025), National Society of Black Engineers (NSBE) (National Society of Black Engineers, 2025), and American Indian Science and Engineering Society (AISES) (American Indian Science and Engineering Society, 2025) each supports underrepresented groups through scholarships, mentoring, and leadership opportunities. The Community Engineering Corps (CECorps) (Community Engineering Corps, 2025) —a joint initiative by ASCE, the American Water Works Association (AWWA), and Engineers Without Borders U.S. (EWB-USA) — provides pro bono engineering services to underserved communities, improving infrastructure and quality of life while offering experiential learning for volunteers.

The National Society of Professional Engineers (NSPE) (National Society of Professional Engineers, 2025) serves as a multidisciplinary organization addressing the non-technical aspects of professional practice. It supports licensed engineers through continuing education, legal resources, and leadership training. NSPE also promotes ethical standards and licensure advocacy.

An essential role of engineering professional societies lies in the promotion and dissemination of technical excellence. IEEE, with more than 400, 000 members, and ASME are internationally recognized for their peer-reviewed publications, continuing education programs, and high-impact conferences. For example, SPE publishes widely cited research and organizes the Annual Technical Conference and Exhibition, which draws over 10, 000 attendees globally. Such forums facilitate interdisciplinary engagement and accelerate the development and adoption of new technologies.

Societies also play a critical part in establishing technical standards and best practices. ASME's Boiler and Pressure Vessel Code, used worldwide, ensures mechanical safety. The IEEE Standards Association (IEEE-SA) maintains over 1, 300 active standards encompassing fields from wireless communications to electric grid systems. ASCE issues codes related to structural integrity and infrastructure resilience, while AIChE provides essential guidelines for safe chemical process operations. Other major standardization bodies, such as American Society for Testing and Materials (ASTM) International, the American National Standards Institute (ANSI), the American Petroleum Institute (API), and the International Organization for Standardization (ISO), often collaborate with engineering societies to align practices globally. Several societies are directly involved in standards development: ASME for mechanical safety; SPE for reserve certification in oil and gas; AIChE for chemical engineering process safety; and ASCE for construction, infrastructure, and environmental engineering standards.

Support for licensure and continued professional growth is another cornerstone of engineering societies' missions. NSPE emphasizes professional ethics, licensure advocacy, and continuing education, providing resources to support professional engineers (PEs) throughout their careers. Other societies, such as IISE and AIChE, offer certification programs, webinars, and career tools to ensure members remain up to date in their fields and can pursue leadership roles within the profession.

SWE provides scholarships, leadership development, and advocacy to support women in engineering. NSBE offers resources to help Black engineers achieve academic success, build mentoring relationships, and engage with their communities. AISES encourages American Indians and Alaska Natives to pursue STEM careers through educational programs, scholarships, and professional networking opportunities. These societies contribute to creating a more supportive engineering community.

Engineering societies also serve the public through community engagement and service-oriented projects. The Community Engineering Corps exemplifies this commitment by delivering sustainable infrastructure solutions to underserved areas, often focusing on water access, sanitation, and environmental resilience. Tau Beta Pi, through its dual emphasis on character and scholarship, encourages service and leadership among engineering students. The Order of the Engineer reinforces a sense of personal accountability and ethical integrity through its oath and symbolic ring ceremony.

Collaboration across disciplines and international borders is essential in addressing global challenges. The AAES fosters multidisciplinary cooperation among U. S.-based societies, while global organizations such as the World Federation of Engineering Organizations (WFEO) (World Federation of Engineering Organizations, 2025) and the UK-based Institution of Civil Engineers (ICE) (Institution of Civil Engineers, 2025) support international engagement on issues like sustainable energy, infrastructure, and climate adaptation. These networks amplify the profession's impact and ensure that engineers can contribute meaningfully to solutions beyond national boundaries.

AWARDS AND RECOGNITION

Recognition of excellence remains a central function of professional societies. These organizations celebrate innovation, service, and leadership through a range of awards. NSPE presents honors such as the NSPE Award, the Federal Engineer of the Year Award, and the New Professional Award, recognizing contributions across all career stages. Many distinguished honors are jointly conferred by multiple societies. The Hoover Medal, established in 1929 and awarded by ASME, ASCE, AIChE, American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) and IEEE, recognizes civic and humanitarian contributions by engineers. Notable recipients include Herbert Hoover, the first recipient and namesake of the medal, recognized for his public service. Vannevar Bush was honored for his leadership in science and technology during critical times. Dwight D. Eisenhower, the former U. S. President, received the medal for his contributions to public service. Dean Kamen, known for his invention of the Segway and contributions to medical technology, was awarded for his impactful innovations. Abdul Kalam, the former President of India, was recognized for his work in aerospace and his efforts to improve the lives of millions. Steve Wozniak, co-founder of Apple Inc., was honored for his contributions to computing and philanthropy. These recipients exemplify the spirit of the Hoover Medal (American Society of Mechanical Engineers, 2025), demonstrating how engineers can significantly impact society beyond their technical achievements.

The Elmer A. Sperry Award, granted by six societies, honors advancements in transportation. Among the recipients are Donald W. Douglas, recognized for the Douglas commercial (DC) series of air transport planes, and Ferdinand Porsche, awarded posthumously for the development of the Volkswagen automobile. Sir Geoffrey De Havilland received the award for his pioneering work on jet-powered passenger aircraft, and Igor Sikorsky was honored for his advancements in helicopter technology.

The Daniel Guggenheim Medal, awarded by ASME, Society or Aeronautics Engineers, and AIAA, acknowledges outstanding achievements in aeronautics. The Alfred Nobel Prize, presented by ASME, ASCE, AIME, and IEEE recognizes exceptional technical papers authored by individuals under the age of 31. The Joan Hodges Queneau Award, jointly administered by multiple societies, celebrates significant contributions to environmental conservation. These honors illustrate the shared commitment of engineering societies to uphold excellence and inspire future generations.

NAE offers eight awards. These include seven named awards for engineering achievement and innovation (Brierly & Fletcher, 2025). The Charles Stark Draper Prize for Engineering is awarded biennially, recognizing engineering achievements in any field of engineering, and can also be awarded to nonmembers. The Fritz J. and Dolores H. Russ Prize, awarded biennially, recognizes an outstanding bioengineering achievement in widespread use that improves the human condition. The Bernard M. Gordon Prize for Innovation in Engineering and Technology Education recognizes new modalities and experiments in education that develop effective engineering leaders. The Simon Ramo Founders Award honors an outstanding NAE member who has upheld the ideals and principles of the NAE through professional, educational, and personal achievement and accomplishment. The Gibbs Brothers Medal recognizes outstanding contributions in the field of naval architecture and marine engineering. The J. C. Hunsaker Award honors excellence in Aeronautical Engineering. The Arthur M. Bueche Award honors an engineer who has shown dedication to science and technology, as well as active involvement in determining U. S. science and technology policy, promoting technological development, and contributing to the enhancement of the relationship between industries, government, and universities.

The NAE Council may also confer the title of "Distinguished Honoree" on any living individual, including current members of the NAE, in recognition of exceptional achievement in, or distinguished service to, the advancement of engineering and its benefits to humanity, the engineering profession, or the NAE itself. Non-members who receive this honor are granted all the privileges of NAE membership, with a few exceptions. Only five individuals have received this honor in the Academy's history.

PUBLICATIONS AND REPORTS

Engineering and technology-related studies and programs span multiple operational units within NASEM. The outcomes of these efforts are published as reports and proceedings that contribute to the expanding body of knowledge on engineering practice and policy. These publications are available through the National Academies Press, where most reports can be read online or downloaded as free PDFs.

The Bridge, NAE's flagship quarterly journal, offers opinion and analysis on topics spanning engineering research, education, and practice; science and technology policy; and the broader role of engineering in society. Its goal is to inform and stimulate dialogue among NAE members, policymakers, educators, business leaders, and engaged citizens.

NAE Perspectives (no longer published) provided a platform for practitioners, scholars, and policy leaders to share insights on emerging developments, challenges, and opportunities in engineering.

Spotlight on Engineering, the NAE's monthly e-newsletter, highlights engineering and policy activities from across the National Academies, along with news, events, and global updates relevant to the engineering community.

Proceedings of the National Academy of Sciences (PNAS) *Nexus* is a gold open-access journal launched in 2022 by the

NAS. It publishes high-impact research that spans science, engineering, and medicine, with a focus on multidisciplinary, interdisciplinary, and transdisciplinary work. Building on the legacy of the PNAS, PNAS Nexus provides a platform for emerging fields and boundary-pushing research. Its rigorous peer-review process and open-access model are designed to promote broad accessibility, foster collaboration, and accelerate scientific discovery. Researchers are encouraged to submit their work to PNAS Nexus.

Memorial Tributes is a compilation of personal remembrances that commemorate the lives and outstanding achievements of deceased NAE members. The tributes stand as an enduring record of the contributions of engineers and the societal impacts of engineering. In most cases, the authors of the tributes are contemporaries or colleagues who had personal knowledge of the interests and engineering accomplishments of the deceased. These essays are carefully prepared and reviewed, preserving not only professional legacies but also the character and values of the individuals remembered. The volumes are published annually and are freely available to the public online and serve both as a historical record and a source of inspiration for current and future engineers.

EVENTS AND FACILITIES

NAE holds Annual Meetings in Washington, D.C., in conjunction with the induction of new members. Notable speakers and panelists make presentations around an annual theme, and many of the awards are presented. Most sections only meet in person at the annual meeting. National meetings are held in Irvine, California, at the Beckman Center (Daderot, 2006). The theme of the March 2025 National Meeting was "Engineering Innovation for a Brighter Future, " which emphasized "the importance of taking risks, learning from failures, and addressing the evolving societal needs of the 21st century through innovative engineering". Nonmembers are welcome at these meetings.

Regional Meetings are held several times annually and serve to engage more of the public, along with NAE members, on specific targets. In April 2024, a regional meeting was hosted at Texas A&M on the topic of "Space and Time, " with keynote speakers including Jeffrey Sherman from the National Institute of Standards and Technology (NIST) and Andy Weir, the author of The Martian. The May 2025 meeting at the University of California at Berkeley will focus on "Artificial Intelligence in Engineering, " featuring talks, panel discussions, and lab tours that explore the transformative impact of Artificial Intelligence technologies across engineering disciplines. In March 2024, Georgia Tech hosted a meeting on "Accelerating Clean Energy Manufacturing, " bringing together leaders from academia, government, and industry to examine strategies for strengthening U. S. energy and supply chain innovation.

Member-led (MLE) and section-led events are convening activities around a common technical theme. These can include a variety of formats, such as recent MLE webinars titled "Carbon Utilization Infrastructure, Markets, Research and Development" and "Writing Effective NAE Nominations. " Others can resemble regional events such as the 2025 MLE sponsored by the University of Tulsa titled "Carbon Capture, Sequestration, and the Future of Energy".

In Washington, D. C., the historic NAS Building on Constitution Avenue serves as the ceremonial and administrative headquarters of each of the National Academies. This landmark facility houses the office of the NAE president, hosts distinguished lectures, exhibitions, and public symposia, and contains the iconic Great Hall with its celebrated dome artwork. A short distance away, the Keck Center on Fifth Street NW functions as the main hub for study committee meetings, workshops, and interdisciplinary collaboration. Designed for flexibility and modern scientific engagement, it includes multiple conference rooms, breakout spaces, and videoconferencing capabilities to support hybrid and remote work. On the West Coast, the Arnold and Mabel Beckman Center of the National Academies of Sciences and Engineering —located on the research park of the University of California, Irvine—serves as a key venue for meetings, retreats, and educational programs. With tranquil gardens and purpose-built meeting spaces, the 48, 000 square foot Beckman Center (Figure 5) hosts many events for the NAE and the broader Academies community, supporting the national and global reach of their science and engineering initiatives.

HOW CAN NONMEMBERS BE INVOLVED IN NAE

Only a relatively few engineers are elected annually to the NAE, many of whom have received their Society's highest awards. This does not mean that many more engineers cannot be involved in NAE activities. One of the most direct forms of engagement is through participation in NAE-sponsored events, workshops, and public symposia. These events often focus on topics such as energy systems, carbon management, sustainability, and innovation—areas where engineers can offer critical expertise and insights. In particular, when the NAE conducts consensus studies or workshops that touch on the oil and gas industry, it seeks input from qualified

Figure 5. Beckman Conference Center, National Academies of Sciences and Engineering.

professionals and scholars, including those from their respective professional communities. Most committee members (typically 80%) are not NAE members. There are opportunities to serve as invited speakers, reviewers, or contributors, especially for reports that require deep technical knowledge or real-world operational perspectives.

Engineers can contribute to NAE publications such as The Bridge by submitting essays on engineering challenges and opportunities related to their areas of expertise. By collaborating with the NAE on study activities, public engagement efforts, and engineering education initiatives, engineers play a valuable role in advancing the broader mission of engineering for the public good.

GLOBAL COMPARISONS

The U. S. NAE is part of a tripartite structure under the NASEM, a model that differs from many peer institutions abroad. In contrast, the UK's Royal Academy of Engineering (RAEng) is a standalone national academy that serves as the premier engineering body without a direct formal link to its scientific counterpart, the Royal Society. Similarly, the Chinese Academy of Engineering (CAE) operates independently but in parallel to the Chinese Academy of Sciences (CAS), with both reporting at the national level and playing critical roles in national science and technology policy (Fu *et al.*, 2023; Meehan, 2025; Rüegg, 1992; Zhang *et al.*, 2025). A key difference is that while the NAE works closely with the NAS and NAM under a shared charter and governance structure, many other countries retain a single national academy that encompasses all disciplines. For example, the French Académie des Sciences, the Indian National Science Academy (INSA), and the Russian Academy of Sciences historically merged engineering and science functions, reflecting a more unified tradition. Until the NAE's founding in 1964, the U. S. followed this integrated model as well, with engineering fellows elected into the NAS. The creation of a distinct NAE allowed for more focused attention on engineering-specific challenges and recognition of engineering as a peer discipline to science and medicine. It's also worth noting that while the NAE includes a section for women engineers and supports diversity initiatives, the UK has a separate entity—the Women's Engineering Society—whereas the U. S. also hosts the National Academy of Women (NAW), an informal term often used in advocacy but not a formal NASEM body. This comparative structure illustrates a broader global pattern: while most countries maintain national scientific academies, relatively fewer have distinct academies for engineering, underscoring the NAE's role as both distinctive and influential.

CONCLUSIONS

Engineering professional societies are fundamental institutions that uphold the integrity, relevance, and societal impact of the engineering profession. Through the development of technical standards, support for licensure and professional development, promotion of diversity, engagement in public service, and international cooperation, these organizations ensure that engineering remains a driving force for innovation and the public good. Their continued efforts cultivate a thriving professional community that is responsive to evolving challenges and committed to improving the human condition through engineering excellence.

The NAE exemplifies these principles at the highest level. Its structure ensures independence, its processes guarantee credibility, and its members bring unmatched expertise across disciplines and sectors. The Academy's influence on issues such as energy, safety, sustainability, and engineering education illustrates the power of organized, thoughtful leadership in shaping public outcomes. Educators can look to the NAE's work for authoritative content and emerging priorities in engineering education. Policymakers can learn from its independent, consensus-based approach to complex technical questions, where decisions are informed by evidence rather than ideology. Researchers may find in the NAE a model for interdisciplinary collaboration that is both rigorous and impactful. The Academy's influence depends not only on its institutional design but also on the continued participation of engineers committed to excellence, integrity, and service. Engaging with the NAE offers a pathway to ensuring that engineering remains central to solving humanity's greatest challenges.

DECLARATION

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