# Board 427: Work in Progress: ADVANCE Strategic Partnership for Alignment of Community Engagement in STEM (SPACES)

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Cesunica Ivey is an Assistant Professor of Civil and Environmental Engineering and the PI of the Air Quality Modeling and Exposure Lab at UC Berkeley. Ivey's research focuses on the nexus of air pollution science and engineering and environmental justice. She is an emerging leader in the areas of regional air quality modeling and its applications and community-scale air pollution exposure assessment. Ivey works in partnership with community organizations across California to prevent the over-industrialization of already overburdened neighborhoods. She recently served on a panel at a public hearing for the congressional Environmental Justice for All Act, sponsored by the U.S. Democratic Natural Resources Committee to support the regulation of cumulative burdens in impacted communities. In recognition of her advocacy for frontline communities of the e-commerce supply chain expansion in inland Southern California, Ivey was selected as a member of the American Chemical Society Chemical and Engineering News Talented 12 2021 class and a 2022 Women in Science Incentive Prize winner by The Story Exchange.

**Dr. Shakira Renee Hobbs, University of California Irvine**

Dr. Hobbs' scholarship explores system approaches to environmental engineering, community engaged research, and life cycle thinking applied to the food, energy, and water nexus.

**Dr. Maya A Trotz, University of South Florida**

Maya A. Trotz is Professor of Civil & Environmental Engineering at the University of South Florida. She holds a BS in Chemical Engineering with a minor in Theater from MIT and MSc and PhD degrees in Civil & Environmental Engineering from Stanford University. Dr. Trotz joined the faculty at the University of South Florida (USF) in 2004. She is the PI of a recently awarded National Science Foundation (NSF) National Research Traineeship, NRT – Systems Training for Research on Geography based Coastal Food Energy Water Systemsand has served as Director for NSF funded Research Experience for Teachers (Water Awareness Research and Education), and Research Experience for Undergraduates (Tampa Interdisciplinary Environmental Research), and Department of Education funded (Multidisciplinary doctoral graduate fellowship program at the water-energy-materialshuman-nexus) programs. She also served as a co-PI on an Alfred P. Sloan Foundation Minority Ph.D. award from 2004-2012 designed to increase minority Ph.D. graduates from baselines of 0 in 2004, and has been the departmental program coordinator with 10 Civil and Environmental Engineering (CEE) graduates to date. Dr. Trotz is currently the President of the Association of Environmental Engineering & Science Professors (AEESP) and in 2014 received an AEESP award for Outstanding Contribution to Environmental Engineering Science Education. Dr. Trotz served on the governing council of the Caribbean Science Foundation (CSF), receiving their Distinguished Service Award in 2013. She served as the CSF team leader on the Sagicor Visionaries Challenge for secondary school students designed to promote sustainability, innovation, & Science Technology Engineering

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## Overview

The Strategic Partnership for Alignment of Community Engagement in STEM (SPACES) is a collaborative research effort under the National Science Foundation's ADVANCE program. The overarching goal of SPACES is to build an inclusive academic culture to address intersectional gender-race-ethnicity inequities in Environmental Engineering (EnvE) via the application of evidence-based strategies for systemic change. The two main thrusts of the project are to address systemic problems that cause: (1) underrepresented minority women faculty (URMWF) experiences of isolation in and/or departures from STEM academia and (2) the devaluation of research conducted by URMWF, especially community-engaged research (CER). SPACES is a collaborative effort of faculty and administrators from 11 universities with four leading professional societies. SPACES is adapting evidence-based practices to support women's intersectional identities and catalyze an attitudinal change among individuals and institutional leaders. This process involves the pursuit of 12 objectives crossing the micro, meso, and macro levels and is being operationalized through 11 activities. An overview of the motivations for this project and activities to date is provided below.

## Background

### Environmental Engineering Discipline

EnvE is an interdisciplinary field, embracing engineering, environmental science, basic sciences (chemistry, biology, physics, earth sciences), and public health. EnvE has emerged from its historical roots as a subspecialty within civil engineering (e.g., municipal water, wastewater, solid waste treatment), chemical engineering (e.g., chemical processing and industrial wastes), and mechanical engineering (e.g., combustion-related air pollution) [1], [2]. Many EnvE faculty are rostered in departments with other engineering disciplines (civil, chemical, mechanical). Thus, EnvE faculty considered for promotion and tenure may be reviewed by individuals primarily outside EnvE and/or with different disciplinary backgrounds. This means that to assist EnvE faculty, training must bridge a wide array of groups, disciplinary norms, and cultures.

Unlike older 'core' disciplines with single disciplinary societies (e.g., American Society of Civil Engineers (ASCE), American Institute of Chemical Engineers (AIChE), American Society of Mechanical Engineers (ASME)), EnvE activities are dispersed across an array of professional societies. Key professional societies that EnvE faculty engage with often have a narrower focus on their particular research interests. A number of these groups are partners in the SPACES effort (see Table 1). The Association of Environmental Engineering and Science Professors (AEESP) is comprised primarily of academics including faculty and graduate students. Among AEESP members, 89% engage in research on water/wastewater, 26% on soil and sediment, 21% on energy, and 14% on air (on average, each respondent identified 1.7 topics among options provided in a recent survey) [3].

Table 1. Examples of EnvE Related Professional Organizations

| Organization | Membership, n | Notes | Affiliated with ADVANCE project? |
|---|---|---|---|
| Association of Environmental Engineering & Science Professors (AEESP) | ~950 [3] | Faculty and graduate students; primarily U.S. and some international; conference every other year | Yes |
| American Association of Aerosol Research (AAAR) | ~1,000 [4] | Faculty, graduate students, government employees, and practitioners; annual conference | Yes |
| Water Environment Federation (WEF) | ~30,000 [5] | Wastewater focus; members primarily from public utilities, consultants; DEI core principle [6]; annual and specialty conferences | Yes |
| American Academy of Environmental Engineers and Scientists (AAEES) | 3,662 [7] | More practitioner focused, provides board certification (1871 individuals), training | Yes |
| American Water Works Association (AWWA) | 51,000 [8] | Drinking water focus, public utilities; annual and specialty conferences | No |
| Environmental and Water Resources Institute (EWRI) of the ASCE | 26,000 [9] | Largely working engineers, hydrologists; less academic focus; annual congress | No |
| Air and Waste Management Association (AWMA) | ~5,000 [10] | Worldwide, local sections / chapters; annual and specialty conferences | No |

### EnvE Faculty Demographics

Among engineering disciplines, environmental engineering currently has among the highest representation of female tenured/tenure-track (T/TT) faculty. The ASEE reports 26.3% of the T/TT faculty in EnvE are female, which is higher than the 19.6% overall in engineering and just behind biomedical at 27.7% and engineering management at 26.9% [11]. While EnvE is a long-time leader among engineering disciplines in female faculty, it is about average in the percentage of URM faculty and like other engineering disciplines particularly in URMWF (see Table 2). A survey from the AEESP found that its membership was: 52% white, 24% Asians, 7% Latinos, and 4% African Americans, as well as 5% from outside the U.S. [3].

Table 2. T/TT Faculty Demographics - ASEE 2020 [12]

| Discipline Name | N faculty | % URM^ | % Black / African American | % Hispanic | % URM female ^ | % Black/ African American Female | % Hispanic Female |
|---|---|---|---|---|---|---|---|
| EnvE | 224 | 9.5 | 3.1 | 5.8 | 3.6 | 1.3 | 2.2 |
| All | 28,250 | 7.0 | 2.6 | 4.0 | 1.5 | 0.5 | 0.9 |
| Civil/EnvE | 1656 | 9.2 | 3.0 | 5.9 | 2.1 | 0.6 | 1.3 |
| Civil Engineering | 1832 | 8.2 | 2.2 | 5.7 | 1.9 | 0.4 | 1.4 |

^ URM sum of Black/African American, Hispanic, American Indian/Alaska Native, Native Hawaiian / Other Pacific Islander

Accurate counts of EnvE faculty are difficult. The total number of EnvE faculty reported by ASEE is very low, due to the small number of EnvE departments (n=21). By comparison, there are 82 institutions with ABET accredited Environmental Engineering Bachelor's degree programs in the U.S. [13]. EnvE faculty embedded with other departments are counted there (e.g., civil/environmental (n=81 programs), civil (n=126 programs), etc.). A previous study of faculty in 74 civil engineering departments in the U.S. [14] counted 345 faculty focused on environmental engineering (21% of the total faculty; 68 departments with environmental faculty; the second largest sub-specialty after structural). A survey of AEESP members found that only 2% do not work in an academic institution; 49% work in departments that awarded undergraduate degrees in civil engineering, followed by 42% environmental engineering, 27% civil and environmental engineering, 17% chemical engineering, and 13% environmental science (because a single department can award multiple undergraduate degrees, the percentages sum to more than 100) [3]. Note that AEESP specifically focuses on faculty.

Black, Latina, and Indigenous women faculty face marginalization, exclusion, isolation, and invisibility throughout the fields of engineering [15], including EnvE. A large barrier to fostering the success of URMWF is the culture of engineering, which has been characterized as masculine, competitive, individualistic, and meritocratic [16],[17]. A number of these attributes are problematic with regards to justice, equity, diversity, and inclusion (JEDI) and could detract from the appropriate valuation of research conducted by URMWF. Further, it should not be assumed that white women will be supporters and allies of URMWF [18],[19],[20]; e.g., "there is a long history of white women not being trustworthy allies" [21]. Thus, change within engineering broadly, and EnvE more specifically, is critically needed.

### EnvE and Community Engaged Research

EnvE faculty traditionally conduct laboratory or field-based research that may be experimental or monitoring oriented, and also conduct modeling and simulation research. A recent AEESP survey found that among its members, 86% conducted experimental research, followed by 45% modeling / computations, 23% community engaged, and 20% educational / teaching [3]. More fundamental research tends to be given a greater value in academia than applied research or

‘public scholarship’ [22],[23]. In addition, research by EnvE faculty that incorporates social sciences and qualitative methods is less common.

Community Engaged Research (CER) partners academics with communities to solve real world problems. Intentionally marginalized communities are at the forefront of climate change and experience disproportionate exposure to pollution and contamination. These burdens are common and pursuing environmental justice for these communities is urgent. Many URM faculty engage in CER and work to help their communities, and these faculty are seen as trusted allies to enhance the adoption of EnvE technology [24],[25],[26]. CER requires intrinsically more holistic approaches that challenge the typical engineering culture that views itself as expert, technophilic, depoliticized, and disengaged from public welfare [27],[28],[29]. Evidence suggests that URMWF who utilize CER methods often have the rigor of their scholarly activities questioned or discounted as service [30], which can have deleterious consequences for early and mid-career faculty. Thus, it is of concern that research methodology and focus choices might add to other biased practices to pose additional barriers to the success of URMWF in academia.

## ADVANCE Grant

The ADVANCE Strategic Partnership for Alignment of Community Engagement in STEM (SPACES) is working to promote the retention and advancement of URMWF in EnvE by addressing systemic barriers to academic advancement. SPACES is pursuing 11 activities (see Figure 1); those with significant progress are highlighted briefly below.

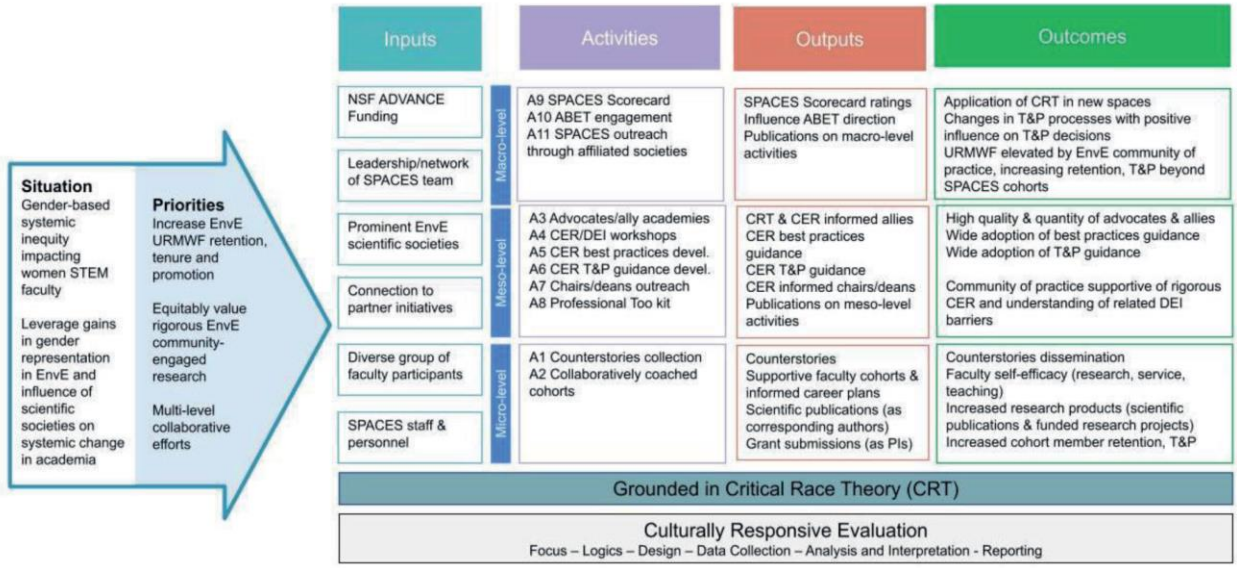

Figure 1. Logic model for the ADVANCE SPACES project

### Activities at the Micro-level

A1. Faculty interviews to collect counterstories
Interviews are underway to collect stories of the experiences of women of color faculty, postdoctoral researchers, former academics, and those with experience conducting community

engaged research from across a spectrum of STEM disciplines. The interviews are grounded in Critical Race Theory. Composite narratives will be published to provide additional levels of anonymity to participants. Negative experiences can be painful to recount and retraumatizing [31], so it is not surprising that several individuals have declined to participate in interviews. Stories from STEM faculty have been published (e.g., [32-35]), including the experiences of EnvE URMWF (e.g., [36]). Therefore, our goal is not to retell traumatic stories but highlight current burdens and triumphs in EnvE, identify factors at play, and forge paths to progress. Those who have participated in the interviews have shared an array of obstacles and challenges that continue to plague URMWF and scholars who engage in CER. Intersections with class and parenting have been discussed. We have also gained knowledge on positive experiences and contributions URMWF make in environmental engineering, including from those who have earned promotion to full professor and served in leadership roles including department chairs and deans while also helping marginalized communities through their work. This evidence-based approach promotes a new lens in EnvE and CER peer reviewed literature to bolster the case for change and provide examples of support.

A2. Collaboratively coached cohorts
These cohorts are bringing together early-career scholars (assistant professors and post-doctoral scholars) from historically excluded groups to support each other. The first cohort in 2023 included 15 scholars (11 women, 4 men). The second cohort in 2024 is still coming together and currently includes 8 scholars (6 women, 2 men). The cohorts met virtually to get to know each other and share their interests and concerns. For example, some scholars disclosed that they had received paternalistic mentorship, so it is important to avoid patronizing or retriggering participants through SPACES activities. It was also noted that junior faculty appreciate autonomy to make decisions and non-transactional support from mentors. Some of the cohort was able to meet in-person at the 2023 AEESP conference. In 2024, the cohorts are being invited to participate together in a writing workshop.

**Activities at the Meso-level**

A3. Advocates and allies academies. The SPACES team offered a workshop at the AEESP conference in 2023. Approximately 15 of the workshop participants were mid- to late-career faculty who stated an interest in serving as advocates and allies. Key personnel in SPACES obtained approval for a new standing (permanent) committee in the AAAR entitled Representation and Equity Affairs (R&EA). Efforts to recruit advocates and allies at the AAAR Conference in October 2024 will be facilitated by an event sponsored by the R&EA Committee.

A4. CER/JEDI workshops at EnvE professional conferences. The SPACES team has offered workshops at the AEESP and AAAR conferences and a presentation at AAEES to educate participants about CER and JEDI issues. A workshop is scheduled at the 2024 Indoor Air conference organized by the International Society of Indoor Air Quality and Climate. The CER workshops are aimed at increasing equity and quality in CER, such that communities will benefit and are not exploited. The work also aims to promote the appropriate valuation of CER in engineering fields, but especially regarding merit review, reappointment, promotion, and tenure.

A5. Development of best practices for CER. A goal is to distill these best practices from the experience of SPACES members and the literature, and tailor them to EnvE. The *Guidebook for the Engaged University* [37] is a rich resource that provides a great springboard for this effort.

A7. Chairs/Deans outreach. A SPACES member was a panelist in the "Trends Impacting Early Faculty Career Path Progression Toward Promotion and Tenure" session at the American Society of Engineering Education's March 2023 Research Leadership Institute, sharing CER challenges and SPACES programming opportunities with approximately 50 engineering associate deans of research. This activity seeks to bring attention to decision-makers about the challenges associated with pursuing CER, especially when conducted by URMWF.

Future activities at the meso-level include: A6. CER Tenure & Promotion guidance; additional A7. Chairs / Deans outreach (likely through the AEESP EnvE program directors group and the ASCE Department Heads and Chairs meeting); and A8. Professional tool kit.

### Activities at the Macro-level

A11. SPACES outreach through affiliated societies is in-progress. Interactions have been the strongest with AEESP and AAAR, due to personal connections with the leadership of these groups and principal investigators of SPACES. For example, members of the SPACES team were also members of the AEESP Community Engaged Research (CER) Task Force and collaborated on a survey to AEESP members in 2023. There has also been some engagement of WEF, Tau Beta Pi, and the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). One CER/JEDI workshop was presented at the Women in Engineering Program (WIEP) Day in October 2023 and a second one is scheduled at the Equity in STEM Community Convening in June 2024, both sponsored by the Women in Engineering Pro-Active Network (WEPAN).

Future activities include a SPACES scorecard that will assess institutional/departmental readiness for CER (A9). In addition, ABET Engagement (A10) has a goal to introduce diversity, equity, and inclusion elements into the ABET EnvE program criteria, similar to their recent incorporation into the Civil Engineering program criteria [38],[39].

## Summary

This ADVANCE partnership grant is a collaborative effort with a focus on the EnvE discipline. The investigators span multiple institutions and are engaging with several professional societies toward a goal of catalyzing significant and systemic change that will foster the success of women faculty of color. A key challenge is intersectionality - consideration of multiple marginalizations that include the EnvE discipline itself (cross-disciplinary but faculty largely embedded in departments where their work is at the edge); challenges of race, ethnicity, gender (e.g., Misogynoir [40]); parenting (e.g., [41], [42]); and those who engage in CER. In this time when DEI activities are under particular scrutiny and attacks, the work is especially critical.

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**Declarations**
This project is being conducted in accordance with research reviewed by Institutional Review Boards for Human Subjects Research at Clarkson University (Protocol 23-31) and the University of Colorado Boulder (Protocol 23-0344).

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