Effective Practices in Equity and Inclusion for ChE Academic Departments

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An inclusive culture has been found to increase the performance and innovation of organizations. Fostering inclusion in academic departments could have many of the same benefits.

Long-overdue attention to issues of diversity, equity, inclusion, and justice is changing approaches to education, chemical engineering practice, and our world in general. The field of chemical engineering is at a critical juncture to improve the inclusion of diverse communities of people within our practice.

Chemical engineering has realized steady gains in our community's diversity, such that women comprise almost 38% on average of BS ChE graduates (with several departments reporting 50% women). Underrepresented minorities — including Hispanic/Latino, Black or African American, and Native American or Pacific Islander — comprise 14% *(1)*. However, the diversity of U.S. chemical engineering faculty still lags well behind, comprising just 19% women, 2.0% African Americans, and 5.0% Hispanic/Latinos *(2)*.

The demographics of the U.S. are changing: 50% of the U.S. population aged 18 and younger were non-white in 2020; this is expected to rise to 64% by 2060, while non-Hispanic whites will no longer be the majority of the U.S. population by 2045 *(3)*. Our graduates must therefore be equipped to work in a diverse national (and global) environment.

Students who have experienced the most diversity in the classroom and in informal interactions with peers have been shown to have the most active thinking and the greatest intellectual engagement, motivation, and growth in skills *(4)*. Recent events have highlighted historical inequities in the U.S. based on race, spurring reflection on what proactive steps should be taken within academia (*e.g.,* policy changes, changes to curricular content) toward improving equity and inclusion beyond diversification.

Diversity has been shown to correlate with business performance, and having diverse teams leads to better innovation, creativity, and complex problem solving, likely arising

from varied life experiences and insights *(5)*. Thus, chemical engineers and the teams we work in will make an even greater impact when we have full representation. However, simply forming diverse teams is not enough, as it does not ensure a culture of inclusion, which fosters fairness, respect, and feelings of belonging. An inclusive culture has been found to increase performance and innovation and result in better business outcomes *(6),* and it would likely show similar results in academic settings.

AIChE has recently committed to advancing diversity, equity, and inclusion (DEI) under the IDEAL framework (inclusion, diversity, equity, anti-racism, and learning), and convened the first National Diversity Equity Workshop for Chemical Engineering Academic Leaders (NDEW-ChE, see sidebar). Building on the topics discussed during the workshop, this article shares some effective practices to foster a culture of inclusion within academic departments and highlights some of the practical steps that academic leaders are taking to improve DEI in the discipline.

Start with discussion and an intent toward action

To make progress in inclusion and equity, leaders must take an active role. One successful approach is to empower a diversity committee to work directly in the department on DEI efforts. To clarify the scope, a department leader can charge such a committee to collect data, make recommendations to the faculty, direct actions and activities, or do a combination of these activities. A department leader may also empower the committee to pursue projects that the committee members value. The key is to facilitate open and constructive conversations and to integrate a culture of DEI into the mission of the department. Many departments have "vertically integrated" committees composed of students, faculty, staff, and even alumni. The committee should have power and support to lead.

For example, Bill Tolman, former chair of chemistry at the Univ. of Minnesota (and now dean of the Univ. of St. Thomas) likens leading departmental culture change to organizing a "flash mob." Like a flash mob, culture change may start with perhaps one or two people doing an activity, and then a few others join, and eventually many join in, resulting in a large impact. Tolman led his department through cultural change around safety *(7)*; he realized that while rules are important, compliance depends on culture, and to change practices and enhance compliance, the culture needs to shift. Tolman advocates empowering students to lead departmental cultural change.

Jim Pfaendtner, chair of chemical engineering at the Univ. of Washington (UW), embraces a holistic approach to DEI that integrates student activism, a formal DEI committee, and proactive leadership from the faculty and chair. Pfaendtner convenes a Chair's Advisory Council monthly,

The First National Diversity Equity Workshop for Chemical Engineering Academic Leaders

In June 2022, with support from the AIChE Foundation's Doing a World of Good campaign and powered by the Open Chemistry Collaborative in Diversity Equity (OXIDE, http://oxide.jhu.edu), AIChE convened the first National Diversity Equity Workshop for Chemical Engineering Academic Leaders (NDEW-ChE). The two-day event, held in Baltimore, MD, allowed leaders to develop practical steps to improve diversity, equity, and inclusion (DEI) in the discipline. Most of the participants were chairs and chairs' representatives from about 50 chemical engineering departments around the U.S. Participants represented research universities, primarily undergraduate institutions, minority-serving institutions, and Historically Black Colleges and Universities (HBCUs).

The workshop followed OXIDE's structure of NDEW meetings held for chemistry department leaders over the past decade. With input from experts in the social sciences and business world, participants learned about workplace climate, biases, and barriers, and how to manage diversity solutions.

The centerpiece of the workshop was a series of breakout sessions where groups of seven to ten participants were charged with identifying ChE-appropriate solutions to an issue where diversity and inclusion were at stake. Six distinct case studies were tackled, each with potential for conflict — either with the dean, with other departments, with promotion and tenure expectations, with student desires, and/or with department tradition. The case studies did not have "right" answers, but were complex situations that allowed the participants to reflect on multiple angles of the situation; think about how various options affected climate, culture, and inclusion; and hear perspectives of other leaders — without the immediate pressure of a real-life encounter. The breakouts gave leaders practice developing solutions, a chance to interact with people in similar roles/positions, and perspective on how local policies, organizational structure, and resources impact responses and outcomes.

This article is based on the learnings from the 2022 NDEW-ChE event and shares some best practices for academic leaders looking to build a culture of inclusion within their ChE department.

▲ Approximately 50 academic leaders participated in the first National Diversity Equity Workshop for Chemical Engineering Leaders (NDEW-ChE).

where he meets with undergraduate students, graduate students, and postdocs to determine action items. The chemical engineering department at UW has formalized a system of faculty mentoring that includes multiple mentors, guidance from the chair, check-ins, and mutual accountability. UW emphasizes DEI in tenure and promotion, and has clarified the expectations for DEI statements in faculty applications. For example, for faculty searches, they establish a clear rubric before the search starts. Pfaendtner believes that creating an inclusive and healthy climate can substantially boost success in faculty and graduate student recruiting.

Research shows bias is real

Leaders can play pivotal roles in curbing bias, and it is important to know the research quantifying its impacts. For example, 70% of professional women face gender harassment, *i.e.,* hostile and offensive attitudes about gender, notes Vicki Magley (Univ. of Connecticut and member of the National Academies of Sciences, Engineering, and Medicine [NASEM] Advisory Group for the Action Collaborative on Preventing Sexual Harassment in Higher Education). Harassment has at least as great an impact on professional and personal health as unwanted sexual attention *(8)*.

Workplace incivility is highly correlated with gender harassment, and witnessing harassment and devaluing of women in science negatively impacts even those who are not specifically targeted *(9)*. Indeed, much sexual harassment goes unreported, sometimes because policies against retaliation are nonexistent or not effectively enforced, and sometimes because the hostile and offensive behavior is so normalized that it is not labeled as harassment. An important role of leadership is to set, tend, and elevate expectations for treating all colleagues with civility and respect; skills-based training in this area for leaders can be invaluable. Training must extend beyond legal definitions and into structures for changing culture.

Another manifestation of bias is stereotype threat, when someone has a fear of confirming a negative belief about a group they represent (*e.g.,* expecting poor academic performance because of racial stereotypes), which affects their ability to perform at their potential. In studies led by Denise Sekaquaptewa of the Univ. of Michigan, the lack of own-group peers and role models for women and African American students resulted in lower performance compared to similar interactions in non-solo groups *(10, 11)*. The recommendation from these studies for science, technology, engineering, and mathematics (STEM) training is to highlight diversity in examples and course homework, carefully compose student groups, and be conscious about priming students for success in assignments.

Biases can manifest unconsciously in physical responses, as demonstrated in work led by Valerie Jones Taylor of Lehigh Univ., which simulated interracial interactions in virtual reality (VR) *(12)*. In a virtual encounter with a Black avatar, white participants engaged in a scene with televised news pieces on either neutral topics or reports on police violence. Preliminary evidence suggests that the piece including police-involved violence triggered unconscious efforts to avoid eye contact and a reluctance to speak with the Black avatar. Taylor's work examines how multiple VR interracial encounters in STEM contexts can shift racial attitudes and improve interracial relations.

National data and data from the Univ. of Michigan show that Black, Indigenous, and People of Color (BIPOC) experience a more negative workplace climate than their white colleagues, and BIPOC faculty often cite climate as a reason for leaving their university. Chemical engineering professor and director of the ADVANCE program at the Univ. of Michigan, Jennifer Linderman, leads a new effort at Michigan to orient leaders to steps they can take to improve climate. The RISE (Respect in Striving for Excellence) Committee of senior faculty and staff has been highlighting strategies including interrupting undesired behaviors, improving organizational structures and policies to promote fairness, setting expectations, and acknowledging and addressing historical legacies of white dominance.

In an analysis from the Univ. of California, Hastings College of the Law, Joan C. Williams describes what bias looks like in real workplaces *(13)*. Williams notes that in both job applications and performance reviews, white men are more often credited for growth potential compared to women and to persons of color (of any gender). In addition, research shows that objective rules and requirements often are applied leniently to white men but rigorously to other groups. To combat these forms of bias, establish criteria before viewing individual applications, apply those criteria consistently (with evidence required), consider accomplishments and potential separately, and check for demographic patterns in who is seen as having potential. Because first-generation college students tend to choose colleges closer to home (and nearly 70% of people of color are first-generation college students), extending searches beyond traditional "top tier" schools is important for inclusive recruiting.

Men self-report much higher access to career-enhancing work, and much lower loads of "office housework" like mentoring, scheduling meetings, making event arrangements, etc. *(14)*. To counter this, leaders should not staff office housework by asking for volunteers, because women will be under strong informal pressures to volunteer; instead, leaders should assign housework tasks in a rotation, keep track of who does what, and look for demographic patterns.

Chemical engineering pioneers say to "Do what you can, from where you are"

Early pioneers from marginalized backgrounds faced many challenges, including feelings of exclusion, inappropriate and hostile comments, and solo status. So much can be gained by listening to the experiences of chemical engineering pioneers and their recommendations.

For example, Gayle Gibson, one of the first "out" LGBTQ+ chemical engineers at a high level in industry and a leader in AIChE's LGBTQ+ & Allies community, provides a valuable industry perspective on LGBTQ+ inclusion. She notes that students have high expectations for their places of work, expecting trust, respect, stability, a sense of purpose, a sense of self-efficacy, and the ability to speak truth to power. Unfortunately, data indicate that LGBTQ+ people in STEM more often experience insensitive comments, feel they don't fit in, think their mistakes are more noticeable, and are less likely to feel they are included in conversations *(15)*.

Gibson, who is part of a consulting company focused on improving workplace climate, envisions leaders as change agents who shape workplace culture by encouraging or disallowing behaviors. As she transforms organizations, she maps DEI efforts on a continuum ranging from symbolic (performative actions limited to, say, one diversity lunch) to metrics-driven (quantifying climate) to culturally integrated, where inclusion is woven into the fabric of everyday interactions (Figure 1).

Practical guidance for leaders includes getting educated (*e.g.,* safe space training), ensuring lines of communication are open, setting policies that reflect inclusive values, holding others accountable, acting as an advocate, and embracing intersectionality. Those in leadership positions should remember that change takes time, and that small steps should not be underestimated. Finally, Gibson credits the Human Rights Campaign (www.hrc.org) for driving LGBTQ+-friendly policies in industry through their ever-evolving Corporate Equality Index; a similar approach might benefit academia by defining specific inclusive policies and practices.

Another valuable perspective comes from Christine Grant, 2022 AIChE President. In 1989, she became the first African-American woman professor in the College of Engineering at North Carolina State Univ. (NC State) and the only one there for 16 years. She later became the inaugural Associate Dean for Faculty Advancement in the NC State College of Engineering. In this role, she advised administrative leaders, empowered faculty success, and managed the college-level reappointment, promotion, and tenure processes.

As advice to department leaders, she offers best practices born of her personal experiences and her professional leadership across multiple national initiatives and organizations. Highlights of her "10 C's" for those wanting to create inclusive environments include *(16)*:

• Celebrate until it counts: give formal, named rewards and celebrations of excellence and inclusion. When necessary, work outside of formal systems, creating innovative awards.

• Correct colleagues swiftly — and publicly, as appropriate — when non-IDEAL behaviors occur.

• Construct a department that empowers fit — actively welcoming and including new people and not leaving faculty members isolated.

• Console faculty members when personal loss occurs to create an empathic culture.

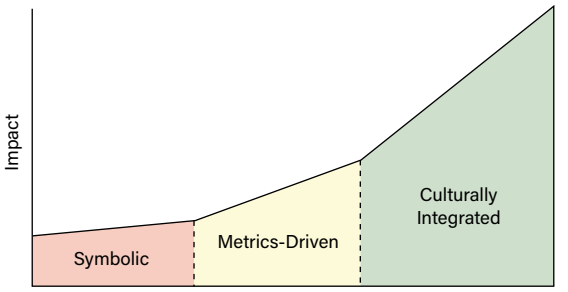
• Create constructive ways to involve faculty in culturally inclusive social events.

Above all, Grant encourages engineers to "do what you can from where you are" to create a culture of inclusion.

Adopt language and norms of engagement that support the IDEAL framework

The very language that we use to describe marginalized communities can impede our pursuit of cultural transformation.

An example is the term underrepresented, commonly used to identify Black or African American, Latinx or Hispanic, and indigenous peoples. David Asai of the Howard Hughes Medical Institute encourages us to revise our language from describing these members of our communities as underrepresented minorities, which identifies the consequence of their treatment in our society and suggests that they are somehow "less than." Asai encouraged the use



Symbolic	Metrics-Driven	Culturally Integrated
Initiatives that typically began in the 1990s. They serve to improve awareness, promote cultural understanding, and attempt to create inclusion.	Top-down initiatives usually driven by senior leadership to establish clear metrics to help drive diversity. Elements of the symbolic typology can be included.	Part of an umbrella strategy integrated into direct executive line of sight. Data-driven and outcomes-based. Elements of Symbolic and Metrics-Driven typologies are included.

▲ **Figure 1.** Diversity, equity, and inclusion (DEI) efforts can be mapped on a continuum ranging from symbolic to culturally integrated. Image courtesy of Accordant Advisors; used by permission.

of the term PEER, which stands for persons excluded on the basis of ethnicity or race; the term highlights the active discriminatory role of the systems we operate within.

Our PEER colleagues and students — and those our profession impacts more broadly — are not "less than." They have been deliberately or passively excluded by the norms, policies, practices, and language we embrace in our educational system and profession. Unfortunately, science has often been the very tool used to support supposed justifications for racism, such as measurement of skills relating to intelligence or suggesting predisposition for transmitting disease, which have been widely disproven, and from which racial classifications emerge as a tool of oppression *(17, 18)*.

It is not uncommon to blame the underrepresentation of certain groups in STEM on lack of interest or lack of preparation, with efforts to bolster numbers focusing on K-12 or graduate-to-faculty pathways rather than on focusing on the need for an inclusive climate to offer authentic belonging to PEERs. Although outreach efforts have increased diversity in undergraduate numbers, these interventions have not resolved underrepresentation at graduate and faculty stages, nor have they positively changed the climate.

PEERs continue to leave STEM programs (and the ranks of STEM faculty) in disproportionate numbers, partly because of our failure to look within our academic communities and ask how our institutions need to change. A key hurdle to overcome is being comfortable with the language around the problem. Leaders can study anti-racism resources (Table 1) and focus on listening skills to better understand the experiences of PEERs and the shape that exclusion takes in our institutions.

According to Asai, the path to inclusive excellence must leverage the full breadth of talent available, and engineers and leaders should start by questioning our assumptions and learning to talk about our differences.

Mark Nagy (Xavier Univ. and Wendal Inc.) has suggested that enforcing norms of workplace civility improves the openness of conversations and inclusive cultures *(19)*. Workplace incivility includes disrespectful behavior with three challenging qualities:

- low intensity (or infrequent), which may go unnoticed by bystanders
- ambiguousness, which may or may not be intentionally disrespectful, but is experienced as disrespect by the recipient
- violating unwritten behavioral norms, which may assume shared expectations that do not exist.

Workplace civility correlates with higher levels of job performance, increased innovation and effectiveness, and increased inclusion and sense of belonging. Department heads and other leaders should insist on civil and respectful behavior, and they must help people learn that good intent does not always translate into positive impact. Training and

Table 1. These are key resources for ChE departments working to facilitate more equitable and inclusive communities.

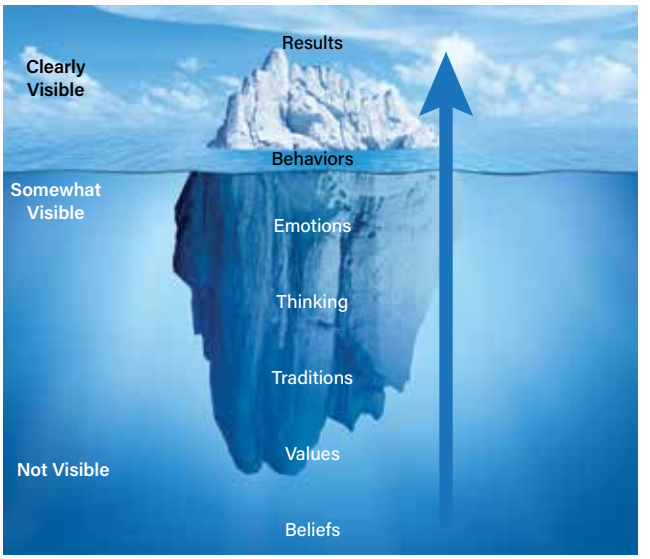
Resource	Description	Link
AIChE's Equity, Diversity, and Inclusion Statement	This statement lays out the IDEAL framework (inclusion, diversity, equity, anti-racism, and learning)	www.aiche.org/equity-diversity-inclusion/statement
National Diversity Equity Workshops (NDEWs) in Chemical Sciences (2011–2017)	A summary of learnings and best practices developed in chemistry-focused NDEWs	pubs.acs.org/isbn/9780841233515
Bias Interrupters	Tools and reports from the Univ. of California Center for WorkLife Law on measuring and interrupting bias	www.biasinterrupters.org
Climate Control: Gender and Racial Bias in Engineering	Results of a study conducted by the Society of Women Engineers (SWE) to understand engineers' experiences with bias in the workplace	https://swe.org/wp-content/uploads/2018/04/16-SWE-020-Work-Study-10_20_16-CP.pdf
Respect in Striving for Excellence (RISE, Univ. of Michigan ADVANCE Program)	Tools for creating inclusive culture, including case studies demonstrating the eight levers	https://advance.umich.edu/rise
Action Collaborative on Preventing Sexual Harassment in Higher Education	Central website of resources from the National Academies with links to multiple resources and policy recommendations for local implementation	www.nationalacademies.org/our-work/action-collaborative-on-preventing-sexual-harassment-in-higher-education
Crossroads Anti-racism Organizing and Training	Institutional frameworks, practices and tools in diagnosing racist structures and deploying strategies toward equitable culture and practices	https://crossroadsantiracism.org
VISIONS, Inc.	Organizational development support in anti-racism	https://visions-inc.org

action for workplace civility should focus on the positive, on what to do (as opposed to what not to do), and on norms for how we treat one another. Collaboratively developing a written code of civil conduct is effective, especially when guided by a trained, experienced facilitator.

By the nature of academic departments as communities, their workplace climate affects not only departmental faculty and staff, but also postdoctoral fellows, graduate students, and undergraduates. In this sense, a department head is not only a supervisor, but also a supervisor and mentor of other supervisors. All departments have traditions, beliefs, values, and norms that contribute to the culture. This culture affects the interactions between its members, and as a consequence, the unspoken norms can inadvertently lead to biased or negative behaviors (Figure 2) *(20, 21)*.

Jennifer Linderman and the Michigan ADVANCE Program (see Table 1) have developed eight levers we can envision using to shift the academic climate toward respect and inclusion:

- environment (physical workspace and how space is used)
- expectations (words, actions, and cues used in a group)



▲ **Figure 2.** Just as an iceberg is not visible below the waterline, the traditions, beliefs, and values of an individual or organization are not visible to others. But these values and beliefs influence the way individuals think, feel, and behave. A culture of workplace civility can help curb biased or negative behaviors in an organization by fostering a set of common values and expectations for behavior. Source: Adapted from *(20, 21)*.

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• interactions (relational dynamics)
• language (communication of shared meaning around ideas, behaviors, and actions)
• modeling (leaders serving as examples)
• opportunities (conditions or circumstances that make it possible to achieve)
• routines and structures (formalized policies and procedures)
• time (how team members use their time to reflect organizational values).

Conclusion

To advance equity and inclusion, everyone must take ownership of the culture and play a role (or at least step out of the way). Academic leaders can take the following steps to foster a culture of DEI:

• Empower faculty, students, and staff to lead the DEI efforts and strive for a culture where ensuring a civil, welcoming atmosphere is everyone's job. Form a departmental DEI committee. Examples of DEI committee activities include implementing surveys to assess bias and climate,

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VALERIE L. YOUNG, PhD, joined the faculty of the Dept. of Chemical and Biomolecular Engineering at Ohio Univ. in 1996. She leads her department's assessment processes and co-chairs the college's Committee on Diversity, Equity, Inclusion, Accessibility, and Belonging. She served the department for 15 years as Chair, and is a frequent organizer of the Department Chairs' Session at the AIChE Annual Meeting. She earned her BS in chemical engineering from Lehigh Univ. and her PhD in chemical engineering from Virginia Tech, and was a post-doctoral fellow in the Centre for Atmospheric Chemistry at York Univ. Her research area is atmospheric chemistry; she teaches at all levels of the chemical engineering curriculum from first-year to graduate.

developing a department diversity action plan, and implementing best practices to reduce harassment. Proactively invite people to share accomplishments on a regular schedule, rather than relying on self-promotion.

• Talk about department climate with all stakeholders regularly. Examples include holding regular meetings with representatives from the department (*e.g.,* undergraduate, graduate, staff, alumni) and having open discussions about civility.

• Educate yourself, and facilitate the education of others, on DEI topics. For example, invite a speaker to present best practices for combating sexual harassment, implicit bias, stereotype threat, etc. Ensure that homework and class examples reflect the diversity of our field.

• Encourage faculty to implement change on the local level within their power and hold everyone accountable for DEI in your department. For example, many faculty can incorporate DEI into their lectures, or hold it as a value within their research groups, or can incorporate it into outreach efforts. Note and value efforts in faculty activity reports.

• To avoid putting PEERs in solo status, ensure that student groups have two or more women or BIPOC students; use group management tools such as CATME (https://info.catme.org) to aid team selection.

• Recognize that relying on volunteerism often leads to inequity in service load; track and rotate assignment of major service commitments and "housework" items.

• Practice inclusive hiring and promotion. Put criteria and priorities in writing before reviewing individual candidates, including consideration of DEI efforts, and remind reviewers to apply criteria consistently. Separately and explicitly evaluate potential vs. performance for each candidate.

Each of us can contribute to a diverse and inclusive culture, and from our current positions, we can empower those around us as well. As a field, we have made progress in creating a more diverse academic landscape compared to fifty or even twenty years ago, yet there remains much work to be done. In this age, department leaders must be fluent in intentional DEI efforts so they can lead and manage these changes. We look forward to the progress we will make together in our field. CEP

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SIL-rated shutdown loops on average; these problems included far higher demand rates than had been predicted, high spurious trip rates, high or even continuous bypass rates, etc. Honeywell's internal data is slightly better than this, in part because the company has been working on ITPM improvements using enterprise data for many years. In private correspondence *(7)*, we found that one company had an issue with four out of five of the SIL-rated loops that were examined. And another company had an issue with one out of every two SIL-rated loops selected at random. This all lends support for the ISA/IEC-61511 requirement.

The other side of the coin is where assumptions turn out to have been overly conservative. Often, we can't change the safeguarding designs for these; the money has already been spent. But we have the opportunity to change maintenance strategy — like testing these loops less often and applying our finite resources to other situations where they will do more good.

In conclusion, applying modern digitalization to process safety offers both safety and economic benefits. CEP

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