Justice, Equity, Diversity, Inclusion (J. E. D. I) in Engineering: Practices and Possibilities

Dr. Ruthmae Sears
University of South Florida

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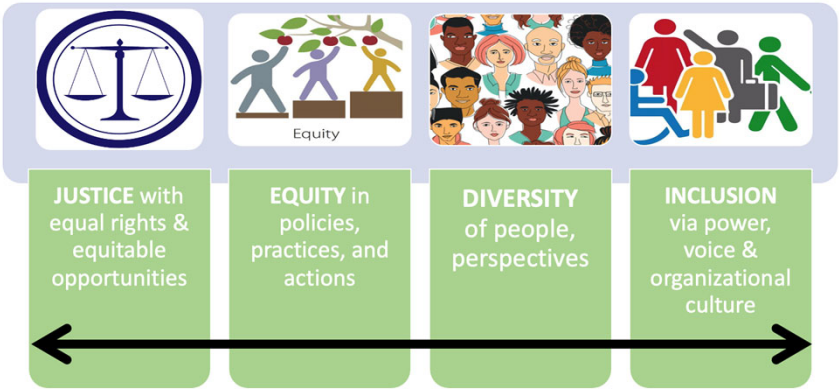
UNIVERSITY of SOUTH FLORIDA

Outline

- Define J.E.D.I
- Discuss data trends
- Imagine possibilities



What Is Social Justice?

Access

Ensuring access to and the fair distribution of human and material resources in society.

Participation

Creating equitable opportunities for people to access information to be fully participatory in decisions that affect their and others' lives.

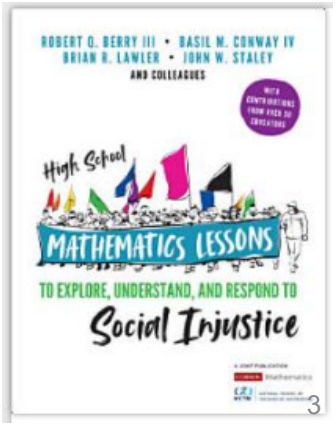
Human Rights

Acknowledging the rights inherent to each and every human being, regardless of race, sex, gender, nationality, ethnicity, language, religion, or any other status. Human rights include the right to life and liberty, freedom from slavery and torture, freedom of opinion and expression, the right to work and education, and many more (United Nations, 2006).

Empowerment

Supporting people' s sense of agency in taking advantage of opportunities society affords as well as working toward eliminating all forms of oppression.

"Social justice means considering the contributions and right of each and every person in society across four ideas: access, participation, empowerment, and human rights (Berry et al, 2020, p.18)



What is social justice?

"While a single definition of social justice may be difficult to come by, the reality is that **social justice movements rely on their own functional definitions every day in doing their work**" (Riley,2008, p.2)

"The Columbia-Barnard wiki on social justice movements in New York City seeks to categorize organizations by topics, which gives some sense of what this group considers to comprise social justice issues as follows:

- Arts-based activism
- Community health and environmental justice
- Economic justice
- Education
- Housing/gentrification
- Immigrant rights
- Lesbian, gay, bisexual, and transgender (LGBT) and two spirit
- Police monitoring/community protection
- Prison crisis
- Reparations
- Women and gender
- Worker's rights
- Youth" (Riley, 2008, p.3)

Social justice means complete and genuine equality of all people.—Paul George, Executive Director Peninsula Peace and Justice Center

Social justice means moving toward a society where all hungry are fed, all sick are cared for, the environment is treasured, and we treat each other with love and compassion.—Medea Benjamin, Co-founder Global Exchange and Code Pink (Figure 1.1)

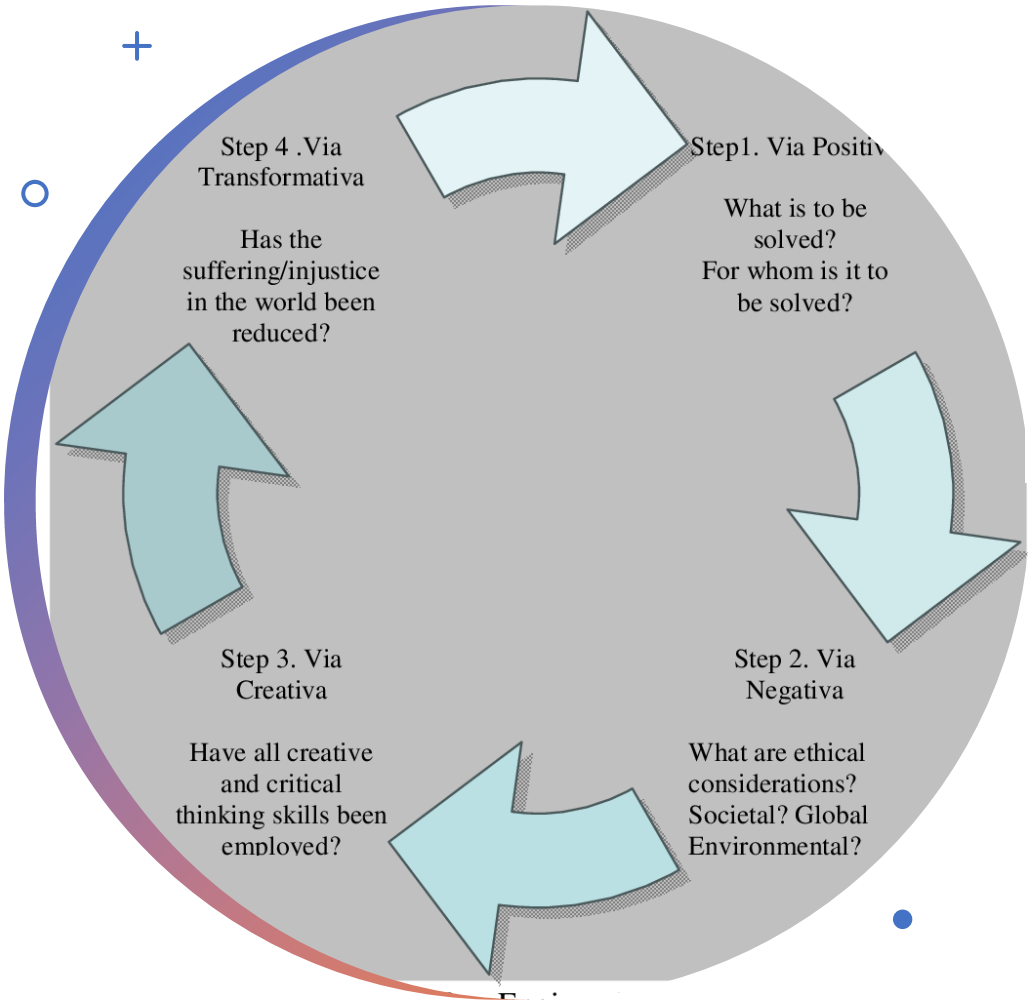
A long and mysterious historical process in which those who are excluded and exploited by social forces of privilege and power attempt to consociate into movements that struggle for: a more equitable distribution of social and economic goods; for greater personal and political dignity; and for a deeper moral vision of their society. Social justice is a goal toward which we move, always imperfectly, and persons and groups are motivated to realize it by their deepest spiritual and political traditions. Justice is only meaningful when it is historically specific and embodied (as opposed to theoretical or abstract).—Ched Myers, ecumenical activist, Bartimaeus Cooperative Ministries

"Social Justice Work" is work that we do in the interest of securing human rights, an equitable distribution of resources, a healthy planet, democracy, and a space for the human spirit to thrive.—Innosanto Nagara, Co-founder DesignAction Collective

Social justice means no kids going to bed hungry, no one without shelter or healthcare and a free and lively discussion and participation by all people in the political direction and organization of our communities and nation.—Kirsten Moller, Executive Director and Co-founder, Global Exchange

[after a longer definition]…It means that those of us who have privilege must be willing to give up those things that cannot be sustained in a fair world—especially those things that use an unfair percentage of the world's environmental resources.—Rick Ufford-Chase, International Director, BorderLinks

(Riley,2008, p.4)



Engineering for social justice (E4SJ)

"We define engineering for social justice (E4SJ) as engineering practices that strive to **enhance human capabilities** (ends) through an equitable **distribution of opportunities and** resources while redu**cing imposed risks and harms (means)** among agentic citizens of a specific community or communities" (Leyden, & Lucena, 2018, p. 15)

"The E4SJ criteria below include:
(1) Listening contextually

(2) Identifying structural conditions

(3) Acknowledging political agency/ mobilizing power

(4) Increasing opportunities and resources

(5) Reducing imposed risks and harms

(6) Enhancing human capabilities "(Leyden, & Lucena, 2018, p. 21)

Engineering Justice (Grimes, & Grimes, 2014)

Table 1. Engineering social justice issues of product design

Issues of Product Design	Sub-Issues		Examples
Accessibility	Ability to functionally use a product		Staircase versus ramp
			Text-based versus graphical user interface
	Ability to acquire product		Monetary costs
			Geographic markets
Sustainability	Production	Depletion of Resources	Depletion of valuable materials
			Harm to environment
		Worker Harm	Use of toxic materials
			Hazardous production procedures
	Consumption	Depletion of Resources	Power consumption to run product
			Resources needed to use product
		Consumer Harm	Hazardous materials
			Hazardous for use

Table 2. Project choice outcomes

	Benefits Stakeholders	Harms Stakeholders
Benefits Impactees (Environment, Consumers, Workers, and Society)	1 Simultaneously Beneficial	2 Hurts the stakeholders but benefits impactees
Harms Impactees (Environment, Consumers, Workers, or Society)	3 Benefits the stakeholders but hurts impactees	4 Simultaneously Detrimental

What are your experiences with considering social justice in engineering?

Reflecting on social justice in the case of Hurricane Katrina (Leyden & Lucena, 2018, p. 2)

"Engineers design, **build and operate complex and imposing systems**, capable of influencing the lives of millions of people, **as well as the allocation of resources** (e.g., water, energy), opportunities (e.g., access to work and commerce), risks and harms (e.g., flooding nuclear disasters, groundwater contamination), and how different social groups receive these differently" (Leyden & Lucena, 2018, p.2)

- In **the case of Katrina, the failure of the levees in New Orleans affected residents who were poor, mostly black, and some with disabilities more than any other social groups, taking away their resources…** Among others, questions that often remain neglected in cases like the design of the levee system include:
  - Who will be at the most and least risk when the system fails?
  - How many deaths are acceptable when the system fails?
  - What costs will those in charge incur if they improve the system? What happens if they do nothing?
  - When a system fails (because it will eventually if not improved), how will people at risk be evacuated? (Leyden & Lucena, 2018, p.2)

What additional social questions can be posed from an engineering perspective relative to the impact of Hurricane Katrina?

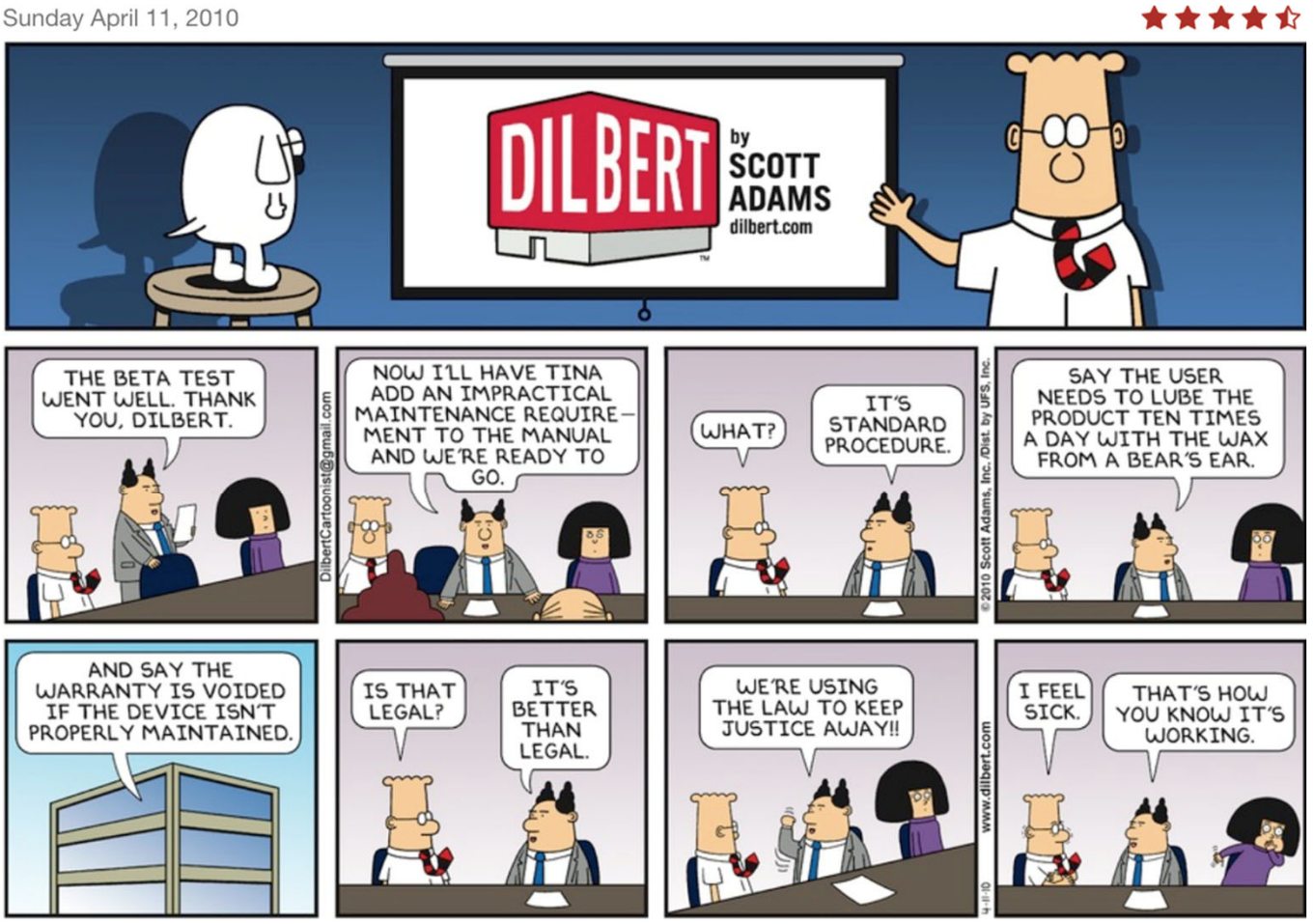
Engineering Justice: Attending to Maslow's Hierarchy of Needs (Grimes, & Grimes, 2014)

Table 3. Maslow's theory adapted and applied to engineer profession

Level	Need	Individual Engineer Development - Motivation	Engineer - Team Motivation	Engineering Product Development
Highest Level	Self-actualization	Realization of Potential	Team has more freedom to determine its path.	Product is something to be proud of and will be for years to come.
	Esteem	Good opinion of self	Team is evaluated positively for high quality performance	Components of the product can easily be rearranged
	Love	Acceptance by organization	Team members feel they belong to the team	Can make necessary changes to fix any problems that exist.
	Safety	Safety Needs – Safety of the Software from external problem(s) (hardware, malicious behavior, etc.)	Safety of the Software from external problem(s) (hardware, malicious behavior, etc.)	Solution will fall within budget requirement and can be created.
Lowest Level	Physiological	Physical Needs – Engineer can function.	Team members perform their function as a team and can deliver their product.	Specifications need to be defined and a general determination of whether it will be possible to make it work.

What are your thoughts of the conversation in the cartoon?

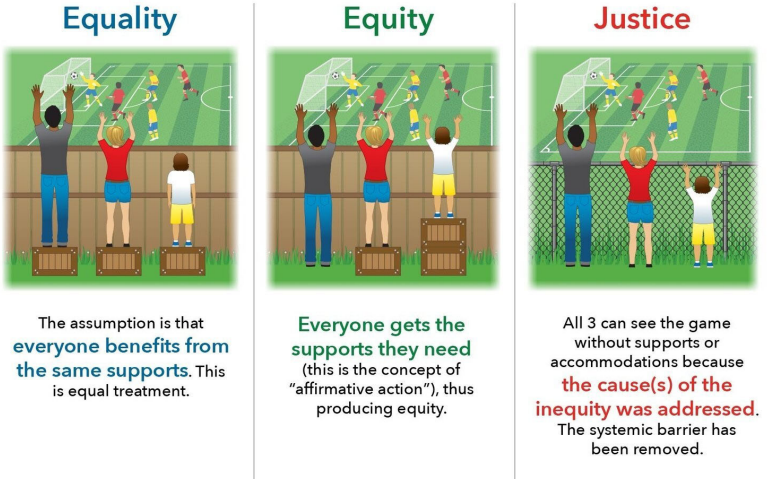
How would you respond to promote social justice in education?



https://dilbert.com/strip/2010-04-11

Equity
(National Academies Press, 2012, P.278)

- The term “equity” has been used in different ways by different communities of researchers and educators.
- Equity as an expression of socially enlightened self-interest is reflected in calls to invest in the science and engineering education of underrepresented groups simply because American labor needs can no longer be met by recruiting among the traditional populations.
- Equity as an expression of social justice is manifested in calls to remedy the injustices visited on entire groups of American society that in the past have been underserved by their schools and have thereby suffered severely limited prospects of high-prestige careers in science and engineering.
- Other notions of equity are expressed throughout the education literature; all are based on the commonsense idea of fairness—what is inequitable is unfair. Fairness is sometimes considered to mean offering equal opportunity to all.



Dimensions of Equity

Gutiérrez (2012) identified four dimensions: access, achievement, identity and power (p.19-20).

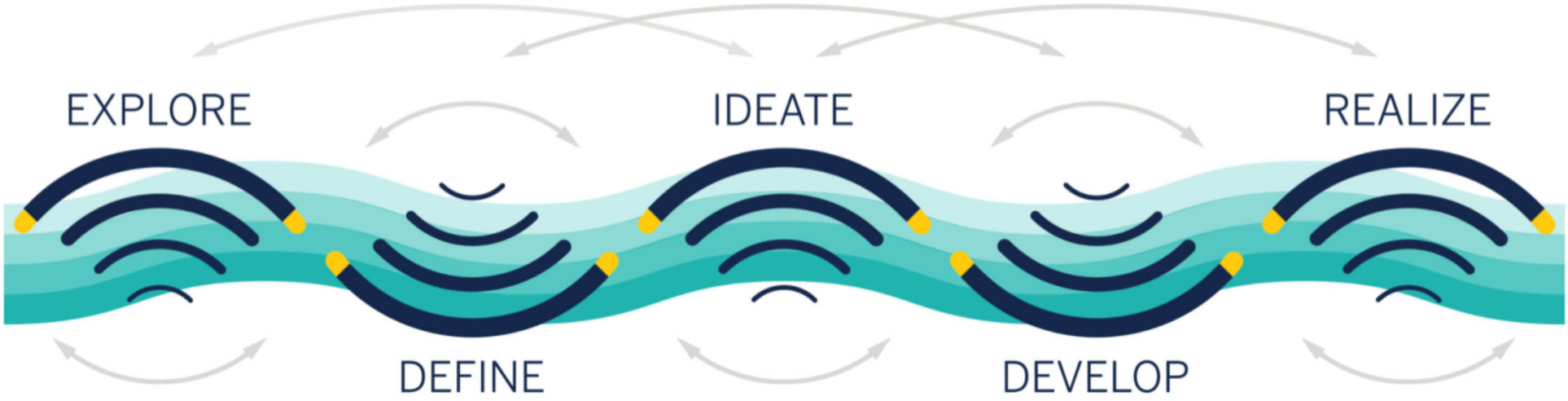
- ***Access*** relates to the tangible resources that students have available to them to participate in mathematics.
- **Achievement** involves, among other things, participation in a given class, course-taking patterns, standardized test scores and participation in the math 'pipeline' (e.g. majoring in mathematics in college, having a math-based career).
- **Identity** dimension concerns itself with a balance between self and others. A window/mirror metaphor is useful here: that is, students need to have opportunities to see themselves in the curriculum (mirror), as well as have a view onto a broader world (window).
- **Power** dimension takes up issues of social transformation at many levels.

It's Time for Engineering to Be Equity-Centered (Gallimore, 2021)

Baked-In Biases

- Women are 17 percent more likely than men to die in a car crash and 73 percent more likely to be seriously injured. Why? In part because crash-test dummies are modeled on men.
- Algorithms keep poor people out of jobs and housing and lead to Black people being held in police custody because they were wrongly identified by a system optimized to recognize features of light-skinned faces.
- Engineered tools have led to improvements in productivity that helped to either entrench or exacerbate income inequality -- limiting opportunities for some while increasing them for others.

https://www.insidehighered.com/views/2021/08/30/diversity-equity-and-inclusion-should-be-required-engineering-schools-curricula



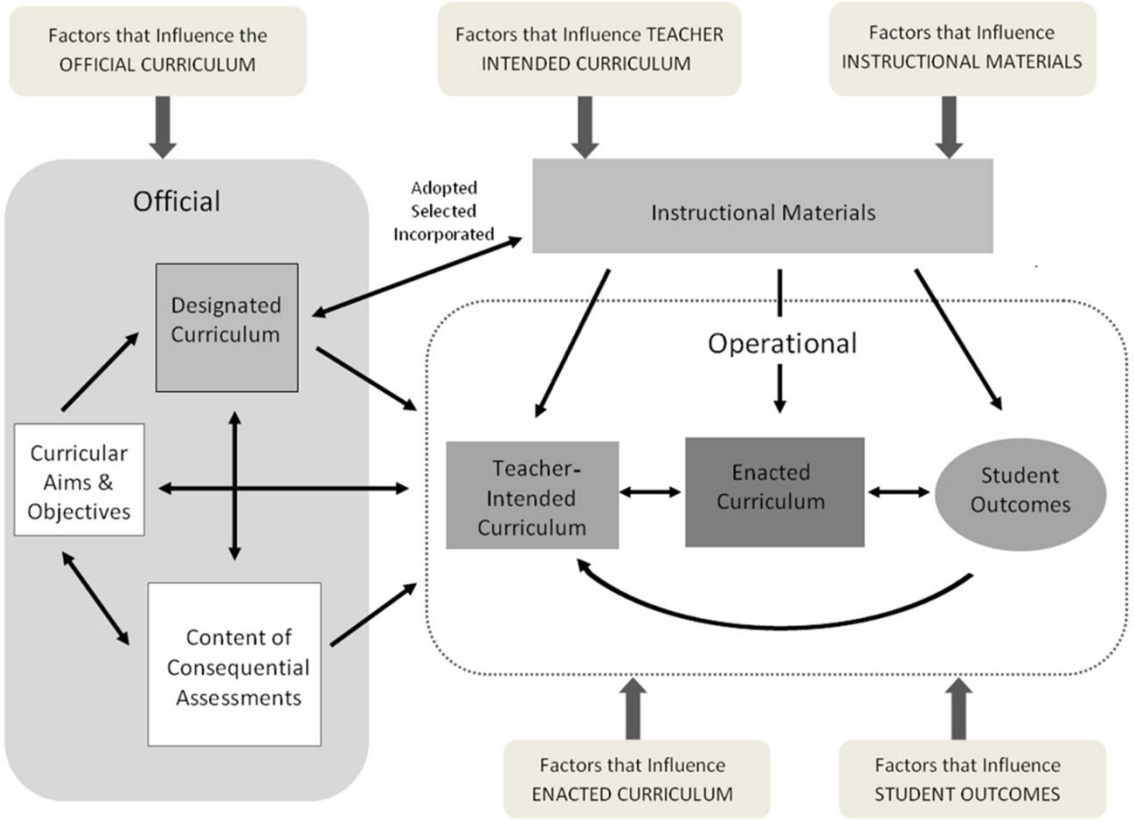
Equity-centered engineering is foundational (Gallimore, 2021)

- It starts with education.
- Society demands rigor in engineered systems, so it goes without saying that technical acumen is a hallmark of engineering education. But engineering is a people-first field. We do not make or use technology in a way that is separate from the culture and society we are part of. We need to teach that in required engineering coursework, threaded throughout the academic experience, as a practical means of addressing or preventing social problems that materially affect the field and society at large.

https://www.insidehighered.com/views/2021/08/30/diversity-equity-and-inclusion-should-be-required-engineering-schools-curricula

- How can we help engineering students promote equitable opportunities in their personal, academic, and professional activities?

- What can faculty do to attend equity in engineering curriculum?



Visual Model of the Curriculum Policy, Design, and Enactment System (Remillard & Heck, 2014, p. 709)

Strategies that can be used to promote diversity and inclusion in software development curriculum (Garcia et al., 2019, p.796)

- Define the indicators of inclusive contexts: equality of opportunities, rights, access to work, treatment, training, access to positions of management and direction, remuneration, and work-life balance, as well as determining the degree of awareness and awareness regarding to the gender gap, people with disabilities or other groups at risk of social exclusion.
- To introduce a coach or external expert figure to contribute to a real world/business vision about technology, diversity and ethics.
- To conduct occasional talks during the course to allow the discovery of different experiences within the technological field and where diversity and inclusion concepts in software development are reflected.
- To introduce gamification techniques to activate the students' motivation about diversity and inclusion within the technological area.

Diversity

- Diversity considers similarities and differences in terms of age, ethnicity, disability, gender and religion, as well as less visible differences such as sexual orientation, disability, religion, educational background, personality type, nationality etc.

Diversity

"Diversity considers similarities and differences in terms of age, ethnicity, disability, gender and religion, as well as less visible differences such as sexual orientation, disability, religion, educational background, personality type, nationality etc."(Royal Academy of Engineering, 2018, p. 6)

"The challenge of diversity, largely in terms of students' profiles or contextual features, is endemic in western education, and is often argued to require differentiation as a response. This can be seen in the presence of different curricula, text materials, tasks, structures or pedagogies. …" (Bishop, Tan, Barkastsas, 2014, P. v)

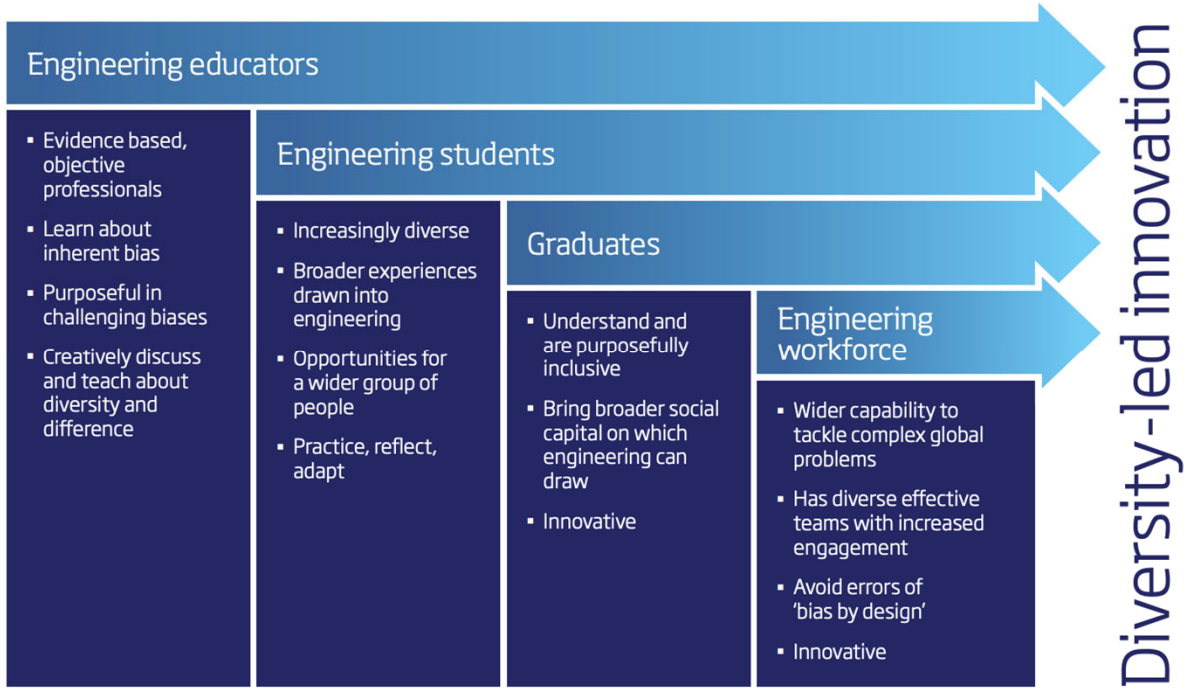
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

NSPE statement on Diversity in Engineering

It is the policy of NSPE to create a **diverse and welcoming environment for everyone interested in the licensed practice of engineering**. NSPE recognizes the **benefits of a diverse popula**tion of licensed engineers in shaping the future of engineering. Diverse backgrounds **foster unique contributions and capabilities and create an inclusive community ultimately leading to a more creative, effective and technically respected community**. NSPE proactively encourages diversity in all areas of the engineering profession and within the organization. NSPE's business entities and volunteer groups are committed to developing business practices and position statements in support of this policy. (NSPE Committee on Policy and Advocacy, Professional Policy No. 01, 2017)

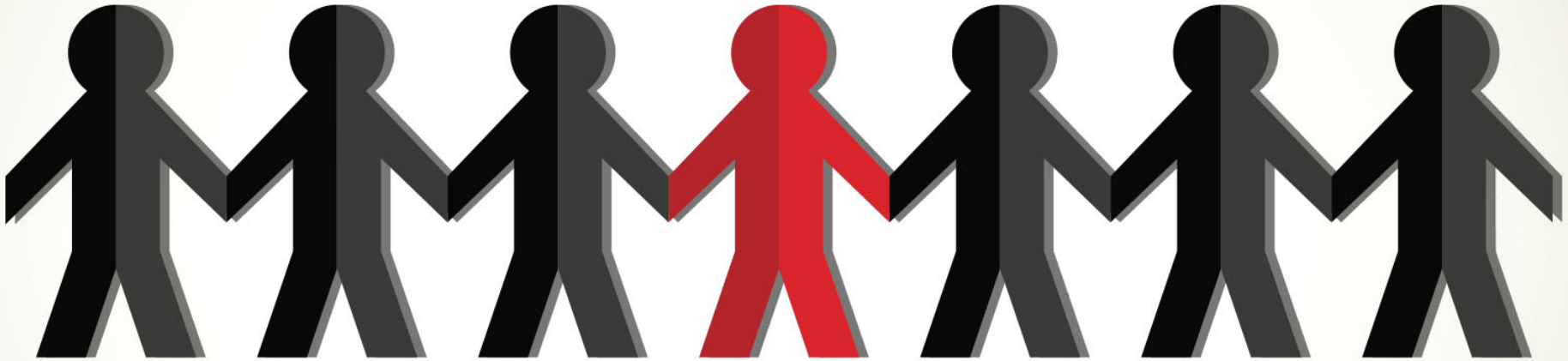
https://www.nspe.org/resources/issues-and-advocacy/professional-policies-and-position-statements/diversity

Driven by Diversity (Ferrini-Mundy, 2013, p.278)



"Diversity of perspectives, ideas, and priorities comes from varied backgrounds, experiences, and cultures, and can help shape science and engineering. As science increasingly is done in teams, collaborations bring diversity to research. Diverse experiences and interactions can support cognitive growth and critical thinking, can benefit problem-solving, and are priorities among STEM (science, technology, engineering, and math) businesses for global competition

- **How to Provide the STEM Workforce for Tomorrow?**
  - *Equitable opportunity to learn from excellent K–12 teachers*
  - *Widespread opportunity to engage in authentic, inspiring STEM learning inside and outside of school.*
  - *Recruit and retain a wide diversity of students into undergraduate STEM courses and majors.*
  - *Preparation for all graduate students for the international science workplace."*



Lack of Diversity in Engineering (Chen et al., 2019, p. 330)

- "**Within engineering, colonial, White and masculine knowledge has historically been privileged over other ways of knowing and has become the dominant discourse** (Baillie and Catalano 2009; Godfrey and Parker 2010; Leydens and Lucena 2017; Riley 2008). Little recognition appears to exist that, not only does the ethnocentricity and masculinity of engineering perpetuate the lack of diversity in engineering, but that mathematical and scientific processes are not race-, gender- and culture-free (Godfrey and Parker 2010).

- This dominant approach **undervalues the lived realities, perspectives and epistemologies of students and faculty who do not fit into this dominant category**. Recognizing and **addressing this systemic bias** created by dominant discursive practices is **critical for successfully reforming engineering higher education to be more inclusive**, particularly when the work is delegated to women and faculty of colour." (Chen et al., 2019, p. 330)

Racial and ethnic group representation in STEM occupations

% of employed who are _____ and total number of workers in each occupation

	Black	Hispanic	Asian	Other	White	Total workers
All employed, ages 25 and older	**11%**	**17%**	**6%**	**3%**	**63%**	**137,400,000**
Computer workers	**7**	**8**	**20**	**3**	**62**	**4,966,711**
Computer support specialists	11	11	11	3	64	611,775
Computer scientists and systems analysts/web developers	10	9	14	3	64	1,636,033
Network and computer systems administrators	9	9	11	3	68	210,647
Database administrators	7	6	20	3	63	116,318
Computer and information systems managers	6	7	15	3	70	610,113
Computer programmers	4	7	20	2	67	371,382
Software developers, applications and systems software	4	5	33	3	54	1,410,502
Mathematical workers	**9**	**8**	**16**	**3**	**64**	**305,242**
Operations research analysts	12	10	11	4	64	148,438
Misc. mathematical science, incl. mathematicians, statisticians	6	7	23	3	62	127,033
Actuaries	4	3	16	2	75	29,772
Engineers and architects	**5**	**9**	**13**	**2**	**71**	**3,034,215**
Engineering technicians, except drafters	9	13	8	3	66	407,163
Computer hardware engineers	8	5	31	2	54	50,187
Marine engineers and naval architects	8	6	5	3	77	14,061
Environmental engineers	7	7	12	3	72	28,676
Electrical and electronics engineers	6	7	18	3	66	218,654
Aerospace engineers	5	9	13	3	71	125,675
Civil engineers	5	9	11	2	73	358,060
Engineers, all other	5	8	18	3	67	554,731
Industrial engineers, including health and safety	4	9	13	2	72	217,249
Chemical engineers	4	6	15	2	73	60,081
Materials engineers	4	6	14	3	72	42,161
Petroleum, mining, mining safety and geological engineers	4	11	11	2	72	33,431
Mechanical engineers	4	8	12	2	74	272,277
Drafters	4	12	7	2	74	145,989
Surveyors, cartographers and photogrammetrists	4	6	3	2	85	34,104
Surveying and mapping technicians	4	9	1	3	82	56,782
Architectural and engineering managers	3	6	12	2	77	171,836
Architects, except naval	3	10	11	2	73	212,005
Sales engineers	2	9	6	3	80	40,093
Life scientists	**6**	**8**	**19**	**3**	**65**	**340,153**
Agricultural and food science technicians	12	15	8	3	62	36,591
Biological technicians	9	16	11	5	59	20,389
Medical scientists and life scientists, all other	6	6	30	3	55	137,019
Natural science managers	5	5	10	3	77	20,965
Agricultural and food scientists	5	5	9	3	78	23,584
Biological scientists	3	7	14	3	73	81,683
Conservation scientists and foresters	2	4	1	3	90	19,922

Notes: Based on employed adults ages 25 and older. STEM stands for science, technology, engineering and math occupations. White, Black and Asian adults include those who report being only one race and are not Hispanic. Hispanics are of any race. Other includes non-Hispanic American Indian or Alaskan native, non-Hispanic Native Hawaiian or Pacific Islander and non-Hispanic two or more major racial groups.
Source: Pew Research Center analysis of 2017-19 American Community Survey (IPUMS).
"STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity"

PEW RESEARCH CENTER

Racial and ethnic group representation across STEM degree fields

Among degree recipients at each level, % who are ...

	White	Black	Hispanic	Asian	Other
Health-related					
Bachelor's	63	9	12	7	3
Master's	63	11	9	8	3
Research doctorate	64	12	6	7	3
Professional doctorate	60	6	7	18	3
Life science					
Bachelor's	60	7	13	13	5
Master's	62	7	9	12	4
Research doctorate	68	5	7	10	3
Physical science					
Bachelor's	66	5	12	10	5
Master's	72	4	9	7	4
Research doctorate	73	3	6	9	3
Computer science					
Bachelor's	55	9	11	16	4
Master's	49	13	8	18	4
Research doctorate	60	7	6	13	4
Mathematics					
Bachelor's	62	5	12	14	4
Master's	64	4	8	15	3
Research doctorate	68	3	6	11	3
Engineering					
Bachelor's	65	5	12	11	4
Master's	62	5	10	13	3
Research doctorate	64	4	6	14	3

Note: Degrees awarded for science, technology, engineering and math fields (STEM) based on U.S. citizens and permanent residents. Engineering includes architecture. White, Black and Asian adults include those who report being only one race and are not Hispanic. Hispanics are of any race. Other includes non-Hispanic American Indian or Alaskan native, non-Hispanic Native Hawaiian or Pacific Islander and non-Hispanic two or more major racial groups.
Source: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System analyzed using the National Center for Science and Engineering Statistics Interactive Data Tool, 2017-18 school year.
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PEW RESEARCH CENTER

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Women's representation in STEM occupations

% of employed who are women and total number of workers in each occupation

	Women	Total workers
All employed, ages 25 and older	**47%**	**137,400,000**
Computer workers	**25**	**4,966,771**
Database administrators	36	116,318
Computer scientists and systems analysts/web developers	30	1,636,033
Computer and information systems managers	29	610,113
Computer support specialists	25	611,775
Computer programmers	22	371,382
Software developers, applications and systems software	19	1,410,502
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Mathematical workers	**47**	**305,242**
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Mechanical engineers	8	272,277
Marine engineers and naval architects	8	14,061
Life scientists	**48**	**340,153**
Natural science managers	56	20,965
Medical scientists and life scientists, all other	55	137,019
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Agricultural and food scientists	35	23,584
Conservation scientists and foresters	27	19,922

Note: Based on employed adults ages 25 and older. STEM stands for Science, technology, engineering and math occupations.
Source: Pew Research Center analysis of 2017-19 American Community Survey (IPUMS).
"STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity"

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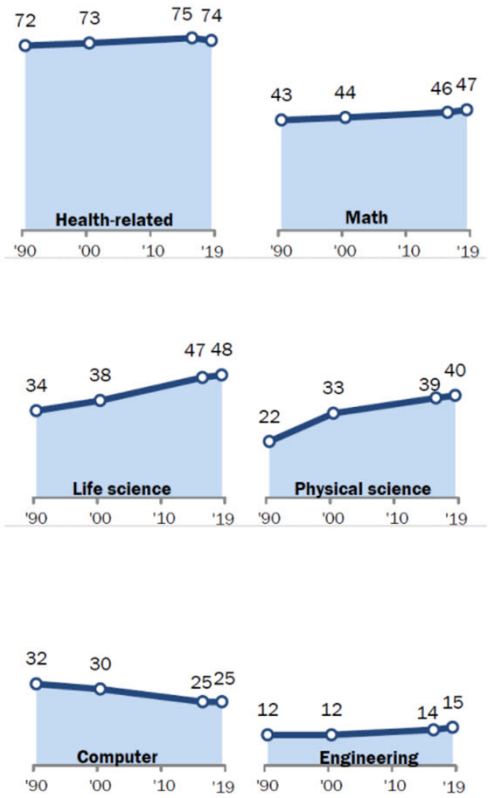
Women remain underrepresented in physical sciences, computing and engineering jobs

Share of employed in each occupational group who are women (%)



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"STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity"

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Women representation in STEM occupation

1. What factors contribute to the lack of diversity in STEM?

2. What could be done to increase diverse representation in STEM?

3. What additional information should be included in the data shared relative to diversity?

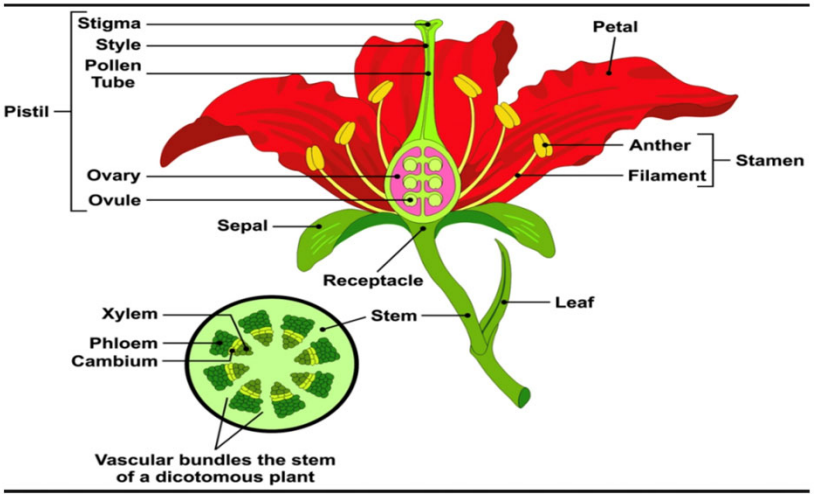
Fry, R., Kennedy, B., & Funk, C. (2021, April 1). STEM jobs see uneven progress in increasing gender, racial and ethnic diversity. *PEW research center*. Retrieved from https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

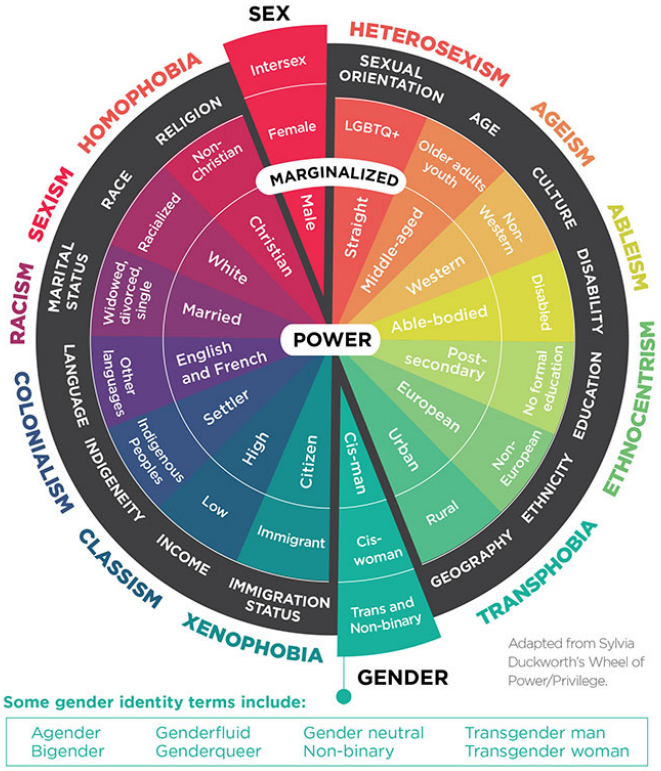
Intersectionality and Identity

Who experience the impact of intersectionality?

Why is it important to be aware of intersectionality and identity?

Describe characteristics that makes you a unique STEM professional, and factors that support you and keep you committed to becoming a leading STEM professional .



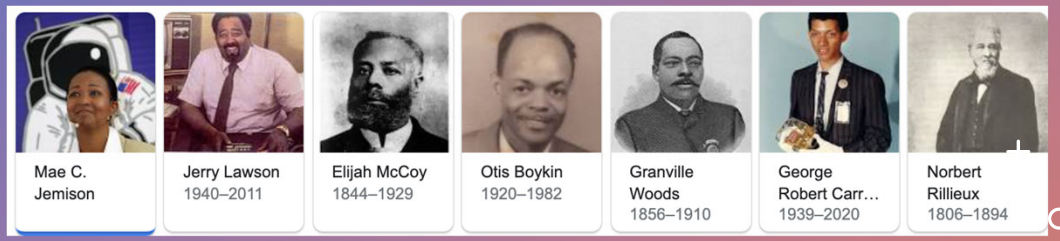


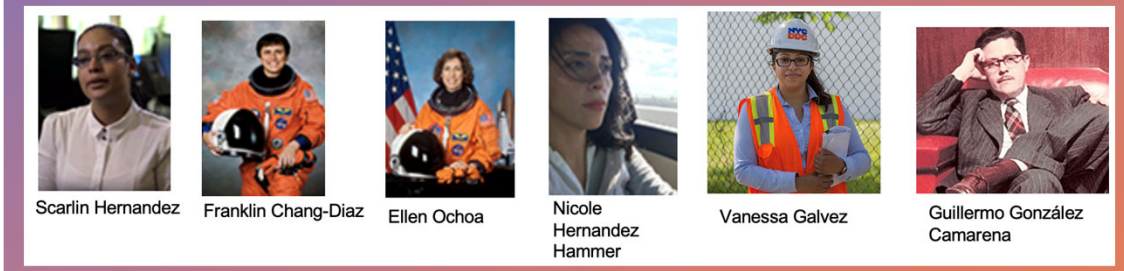
Some gender identity terms include:

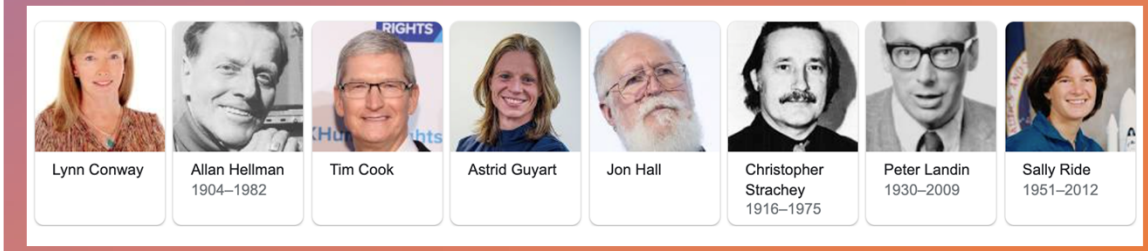
Agender	Genderfluid	Gender neutral	Transgender man
Bigender	Genderqueer	Non-binary	Transgender woman

Famous Engineers

YOU

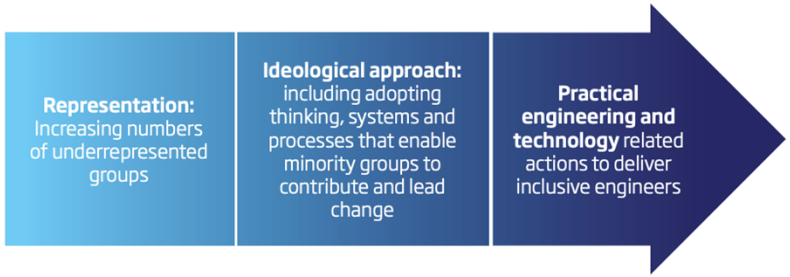


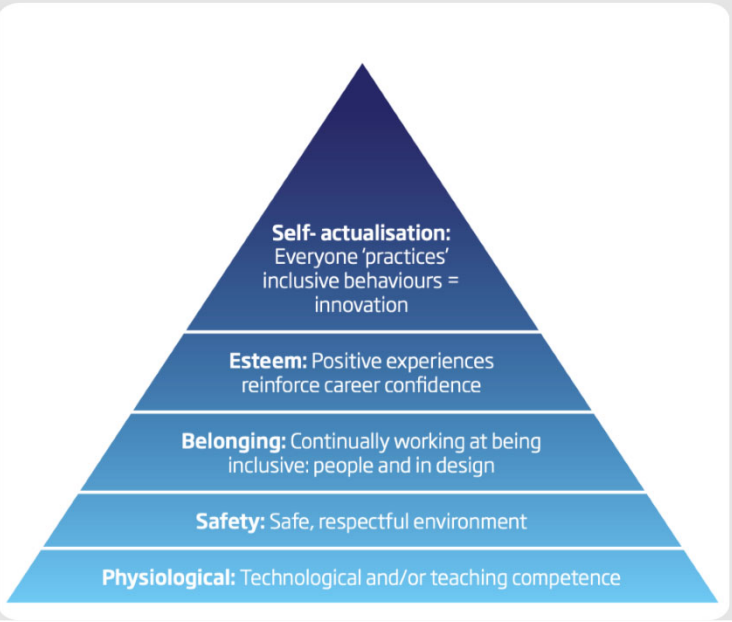




Inclusion

Figure 1: A theoretical approach to change: A three-pronged approach to inclusive engineering education (informed by Soudien, 2010)





(Royal Academy of Engineering, 2018, p. 6)

Inclusion is the extent to which an individual feels valued for who they are in terms of personal and professional background, experience and skills, and the extent to which an individual feels they belong or 'fit' in the engineering profession and in their organization "(Royal Academy of Engineering, 2018, p. 6)

"When the notion of inclusion is used as an ideology, the most extensive discourse concerns equity …; when it is used as a way of teaching, the most extensive discourse relates to teaching interventions for …engagement. " (Roos, 2018, p. 25).

INCLUSION

of all voices and visions

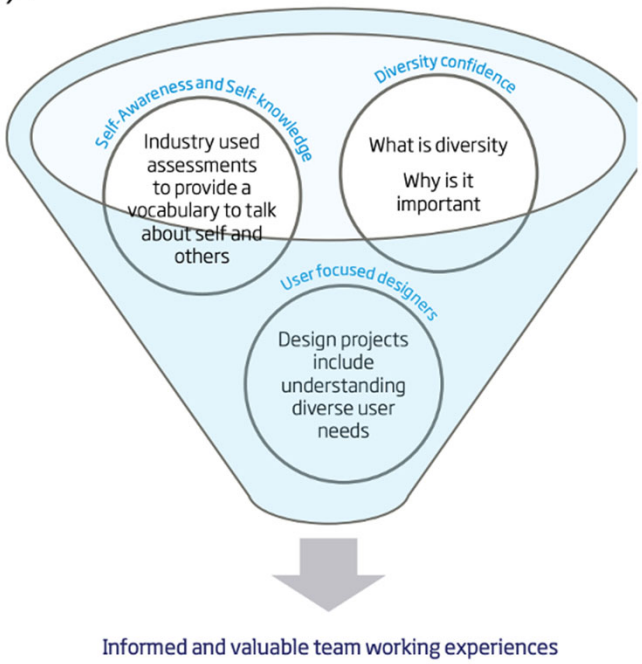
Inclusion within engineering (Farrell, et al., 2017, p. 5)

- " In order to be inclusive, research-based instructional practices such as **active learning, problem-based learning, and service learning, must be carefully designed not to reproduce conventional power structures within engineering**

- Specific recommendations for practical implementation include **collaborative problem solving** in a space where it is safe to make mistakes, **empowering students to bring prior knowledge** and experience into the classroom and **learning to claim authority**, and exploring the people who made important contributions to the field (especially non-majority individuals).

- Mills, et al. frame their work on **gender-inclusive engineering** within constructivist theory, focusing **on the assumptions about prior experience and interest that are inherent in the curriculum, methods, classroom management and assessment**."

Improving the outcomes of student team working experiences to be more relevant to the workplace and society (Royal Academy of Engineering, 2018, p. 29) .

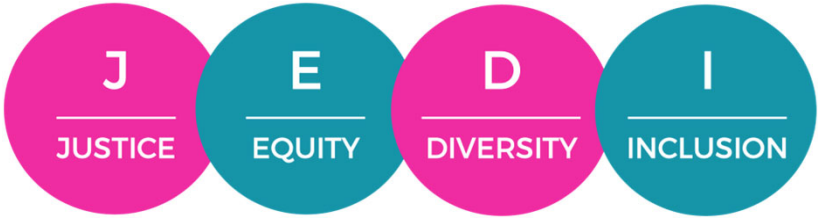


How is excellence judged in your area of engineering?

How might social stereotypes get folded into these definitions of excellence?

*(*National Academies of Science, 2018, *p.2)*

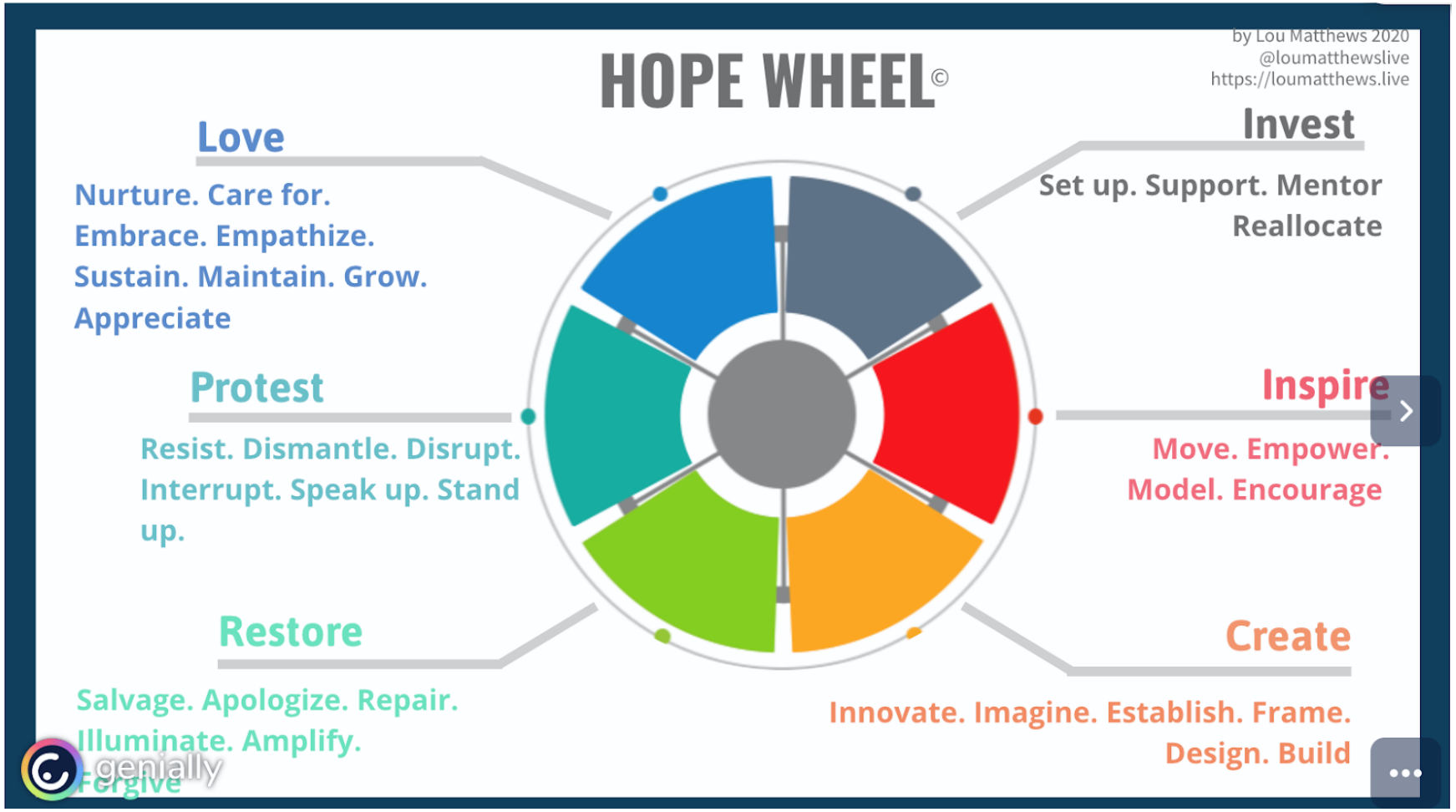
Five elements for the practice of inclusive professional skills (Royal Academy of Engineering, 2018, p. 37)



Strategies to promote JEDI within your organizations and affiliations (National Academies of Science, 2018, P.9-10)

- Examine organizations' institutional structures to determine whether these structures are perpetuating bias.
- Make diversity and inclusion activities pervasive and part of daily practice in an organization rather than compartmentalized and periodic.
- Be systemic rather than programmatic in promoting diversity and inclusion in organizations.
- Incorporate diversity and inclusion considerations, such as the Safe Zone training workshops offered by ASEE, into organizations' discussions and activities.
- Ensure that codes of conduct in academic and industrial organizations mention harassment, bias, and discrimination.
- Set expectations for representation by historically underrepresented groups.
- Consider different dimensions of diversity and inclusion to see which groups are doing well and which are not.
- Involve institutional leadership in discussions of diversity and inclusion issues so that diversity and inclusion are part of leaders' expectations.
- Make diversity and inclusion a core aspect of hiring and evaluation processes.

https://www.nap.edu/read/25323/chapter/1



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QUESTIONS & COMMENTS

Contact Information

Dr. Ruthmae Sears
University of South Florida
4202 E. Fowler Ave., EDU105
Tampa, FL 33620
Office: EDU 308J
Phone: 813-974-2172
Email: ruthmaesears@usf.edu