2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #32315

The Engineering Exchange for Social Justice (ExSJ): Advancing Justice Through Sociotechnical Engineering and Equitable Partnership Exchanges

Dr. Marissa H. Forbes, University of San Diego

Marissa Forbes, PhD is a Research Associate in the University of San Diego Shiley-Marcos School of Engineering, where she works on the Engineering Exchange for Social Justice (ExSJ). Her research areas include broadening participation in engineering education, engineering for social and eco-justice, and water justice. Dr. Forbes earned her MS and PhD from the University of Colorado Boulder in Civil (environmental) Engineering. She previously served as the project manager and lead editor of the NSF-funded TeachEngineering digital library (TeachEngineering.org, a free library of K-12 engineering curriculum), during which she mentored NSF GK-12 Fellows and NSF Research Experiences for Teachers (RET) participants from across the country on the creation and publication of their original engineering curriculum. Dr. Forbes is a former high school physics and engineering teacher and a former NSF GK-12 Fellow.

Dr. Odesma Onika Dalrymple, University of San Diego

Dr. Odesma Dalrymple is an Associate Professor and Faculty Lead for the Engineering Exchange for Social Justice, in the Shiley Marcos School of Engineering at University of San Diego. Her professional pursuits are focused on transforming engineering education and its public image; making it more inclusive and socially connected. This mission is partially actualized through her research, which that explores the wealth of embodied knowledge, skills and practices that under-represented/marginalized communities can bring to bear on engineering practice. These insights are in turn used to inform the development of asset-based engineering learning experiences for middle and high school populations that predominantly comprise students of color from low-socioeconomic neighborhoods, and the creation of guides on how engineers can collaboratively work with communities on grass roots socio-technical challenges.

Dr. Susan M. Lord, University of San Diego

Susan M. Lord received a B.S. from Cornell University in Materials Science and Electrical Engineering (EE) and the M.S. and Ph.D. in EE from Stanford University. She is currently Professor and Chair of Integrated Engineering at the University of San Diego. Her research focuses on the study and promotion of diversity in engineering including student pathways and inclusive teaching. She is Co-Director of the National Effective Teaching Institute (NETI). Her research has been sponsored by the National Science Foundation (NSF). Dr. Lord is among the first to study Latinos in engineering and coauthored The Borderlands of Education: Latinas in Engineering. Dr. Lord is a Fellow of the IEEE and ASEE and is active in the engineering education community including serving as General Co-Chair of the Frontiers in Education Conference, President of the IEEE Education Society, and Associate Editor of the IEEE Transactions on Education (ToE) and the Journal of Engineering Education (JEE). She and her coauthors received the 2011 Wickenden Award for the best paper in JEE and the 2011 and 2015 Best Paper Awards for the IEEE ToE. In Spring 2012, Dr. Lord spent a sabbatical at Southeast University in Nanjing, China teaching and doing research. She is on the USD team implementing ”Developing Changemaking Engineers”, an NSF-sponsored Revolutionizing Engineering Education (RED) project. Dr. Lord is the 2018 recipient of the IEEE Undergraduate Teaching Award.

Dr. Caroline Baillie, University of San Diego

Caroline Baillie is Professor of Praxis in Engineering and social justice

Prof. Gordon D. Hoople, University of San Diego

Dr. Gordon D. Hoople is an assistant professor and one of the founding faculty members of integrated engineering at the University of San Diego. He is passionate about creating engaging experiences for his students. His work is primarily focused on two areas: engineering education and design. Professor Hoople’s engineering education research examines the ways in which novel approaches can lead to better

student outcomes. He is the principal investigator on the National Science Foundation Grant "Reimagining Energy: Exploring Inclusive Practices for Teaching Energy Concepts to Undergraduate Engineering Majors." He has also co-developed a unique interdisciplinary course, Drones for Good, where engineering students partner with peace studies students to design a quadcopter that will have a positive impact on society.

Dr. Joel Alejandro Mejia, University of San Diego

Dr. Joel Alejandro (Alex) Mejia is an assistant professor in the Department of Integrated Engineering at the University of San Diego. His research has contributed to the integration of critical theoretical frameworks and Chicano Cultural Studies to investigate and analyze existing deficit models in engineering education. Dr. Mejia's work also examines how asset-based models impact the validation and recognition of students and communities of color as holders and creators of knowledge. His current work seeks to analyze and describe the tensions, contradictions, and cultural collisions many Latino/a/x students experience in engineering through testimonios. He is particularly interested in approaches that contribute to a more expansive understanding of engineering in sociocultural contexts, the impact of critical consciousness in engineering practice, and development and implementation of culturally responsive pedagogies in engineering education.

The Engineering Exchange for Social Justice (ExSJ): Advancing Justice Through Socio-Technical Engineering and Equitable Partnership Exchanges

Abstract

The University of San Diego's Engineering Exchange for Social Justice (ExSJ) is a framework for community partnership and co-created, justice-oriented solutions to socio-technical challenges. The core tenets of this framework are community-partnered engineering, and engineering education through equitable and reciprocal *exchange* (rather than service) and a *socio-technical* (rather than techno-centric) approach. In this paper, we share: 1) the ExSJ framework, 2) the infrastructure, mechanisms, and activities we are using to apply this framework, and 3) the challenges and complexities we are facing as we apply it. The foundational values of the ExSJ can be applied to all engineering contexts, providing a platform for change that moves away from narrowly constructed and techno-centric epistemological approaches, and an expansion to engage social and environmental justice, humanitarian goals, peace, and sustainability in engineering through equitable partnership exchanges.

Introduction

In 2019, seven faculty and staff members in the University of San Diego's (USD) Shiley-Marcos School of Engineering (SMSE) initiated the Engineering Exchange for Social Justice (ExSJ). The intent was to develop a framework that would facilitate and support the co-definition of socio-technical problems to be solved, and participatory engagement in beginning to solve them across disciplines, campus, and diverse, marginalized community groups. By "socio-technical" we refer to a paradigm that values and emphasizes both the social and technical elements of engineering education and practice, rather than a techno-centric approach that prioritizes the technical [1-9].

The ExSJ's design took inspiration from the original European "Science Shop" models that facilitated science-society collaborations [10] using a bottom-up approach [11] by providing independent, participatory research in response to concerns experienced by community or civil society organizations [12]. The Science Shops operate on a low- or no-fee basis, and are often based in universities, with students carrying out research alongside the supervision of university faculty [10-12]. Originally these were literally like shop- fronts, where community members could drop in and discuss their ideas and needs.

We apply the Science Shop concept to community-partnered engineering with the core tenets of equitable partnership exchanges and a socio-technical engineering approach, which we describe below. However, in addition to the participatory and emancipatory principles of cooperation at all stages of the design, we also work within a social and environmental justice framework for all the projects we undertake [13]. The ExSJ supports the connection between engineering and social justice by providing a system whereby communities are supported to submit project ideas, which are then developed and channeled through professionals and academics to create suitable projects for students through a variety of mechanisms also described in a later section of this paper.

Background

The campus context for the ExSJ is uniquely supportive of initiatives that advance social and environmental justice and socio-technical engineering. USD is an independent, private Catholic University known for its commitment to the formation of values, community involvement, and preparing leaders dedicated to ethical conduct and compassionate service.

In 2015, the National Science Foundation awarded SMSE a five-year Revolutionizing Engineering Departments (RED) grant titled *Developing Changemaking Engineers*, which aspires to a socio-technical engineering education that prepares students to practice engineering within the contexts of social justice, peace, humanitarian advancement, and sustainable practices. The grant also provided the vision and motivation for the hiring of a cluster of new faculty members with interest or expertise in engineering and social justice. The RED grant award and the social justice-focused USD campus culture provided fertile ground to initiate the ExSJ; there is institution-wide support for engineering students to learn to see through the lens of social justice. The ExSJ was seed-funded by an internal two-year university Strategic Initiative Award and advances four of USD's Envisioning 2024 goals: 1) enhancing student learning and success, 2) strengthening diversity, inclusion, and social justice, 3) elevating faculty and staff engagement, and 4) amplifying local and global engagement and reputation. Our Strategic Initiative funding concludes in 2021, and we are moving into a financial model that includes a combination of external and donor funding.

The Engineering Exchange for Social Justice (ExSJ) Framework

When we reflect on the critical questions inspired by materials engineer and socio-technical expert Ursula Franklin [14], *who decides what is engineered and why?* and *who benefits and who pays?*, in the ideal application of the ExSJ framework, all stakeholders have an equitable voice and engage in a collaborative, co-created engineering process so that no stakeholder or community member benefits or pays at the cost of another; costs and benefits are indivisible. In the ExSJ framework, we migrate paradigms from "service" to "exchange" and from "techno-centric" to "socio-technical."

From Service to Exchange

Service-learning (SL) is well-established as an effective pedagogical approach to teaching students the engineering design process [15] and is becoming more common in engineering education [16]. Best practices in SL embrace designing with communities and emphasize the development of reciprocal partnerships [15]. While these practices are coherent with our community approach, we purposefully chose to use the term "exchange" rather than "service." The term *service* connotes a one-directional flow of ideas, resources, and expertise from engineers to community recipients. A uni-directional flow reinforces dominant power structures, inherently imbued with remnants of imperialistic, White, patriarchal mindsets that must be deconstructed [17-21], including at the level of speech. In addition, we question the supremacy and appropriateness of Western science as the key knowledge system underlying science and engineering practice, and acknowledge multiple ways of knowing and being, especially inspired by Native American and other Indigenous traditions [22-23]. In the context of community engagement, *exchange* connotes equal partnership, and a bi-directional flow of ideas, resources, ways of knowing and being, and expertise. For this reason, we call this framework an "engineering exchange."

From Techno-centric to Socio-technical

The ExSJ framework also embodies a paradigm migration from techno-centric engineering to socio-technical engineering. Engineering functions inseparably from the society of which it is a part. The systems that engineers work on are socio-technical rather than purely technical, though the techno-centric paradigm remains the dominant societal association with engineering, and the association that many engineers have with their own profession.

With its roots in the military-industrial complex, engineering curricula have long prized a reputation of "rigor", and engineering students have historically been trained technically, with less focus on critical examinations of assumptions embedded within engineering practice, and even less emphasis on the larger contexts in which engineering is embedded [20][24]. Engineering education needs to prepare students with tools to work with the sociological subsystems and the integrated and adaptive socio-technical systems.

The National Academy of Engineering (NAE) formally recognized that engineering was a socio-technical enterprise in a publication tied to a 1991 symposium, *Engineering as a Social Enterprise*, which made the case for engineers adopting the mindset that the systems they work on are socio-technical [1]. The common engineering approach of subdividing a system for analysis purposes is extended and applied to the advocated socio-technical model, in this case "a vast integrated system, with the varied social and technical areas of human activity as major interacting subsystems" [1]. Attention is given to the interactions between and constraints on the social and technical subsystems and to the eventual task of reassembling the system to legitimize the analysis. Additionally, socio-technical systems are adaptive and constantly changing with time, which adds a significant level of complexity to the process; a level of complexity that traditional engineering training has not necessarily prepared practitioners to deal with.

While the socio-technical model has gained some traction within the engineering community since 1991, there has not been much movement in the training of engineers or educators to adopt this mindset or to acquire new tools to better work with the sociological subsystems or the integrated and adaptive socio-technical systems. In 2015, when NSF awarded USD's RED grant for a socio-technical *Developing Changemaking Engineers* initiative, even though 24 years had passed since the NAE *Engineering as a Social Enterprise* symposium, the efforts of this grant were still deemed revolutionary [2-9].

The Nexus of Socio-Technical Engineering and Community Exchange

The ExSJ operates in the intersected space of socio-technical engineering practice and community engagement through exchange (Figure 1). The exchanges with communities provide authentic sociological contexts and therefore rich opportunities for students to learn and practice engineering with guidance and mentorship from community, academic and professional experts. This process yields solutions that are developed and implemented with focus on facilitating social and environmental.

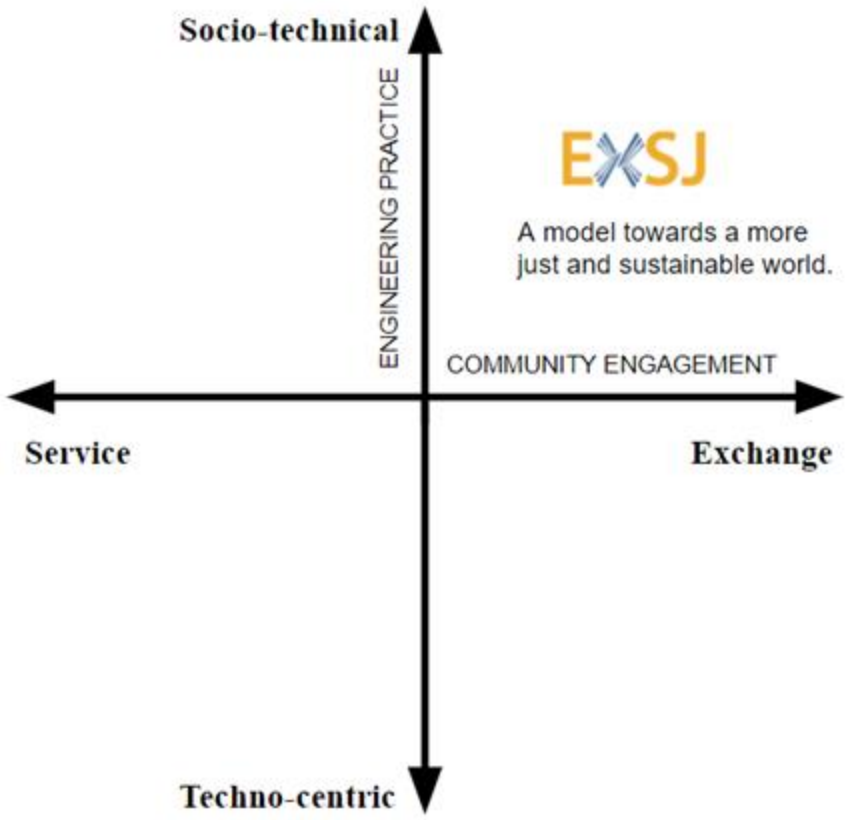

Figure 1: The Engineering Exchange for Social Justice (ExSJ) Framework

ExSJ Infrastructure, Mechanisms, and Activities

The ExSJ's functioning and development is supported by a Leadership Team composed of six SMSE faculty (the authors of this paper) and two staff members. The Leadership Team faculty members have diverse professional, technical, and disciplinary backgrounds that provide for a range of expertise, including in community partnerships, electrical engineering, engineering education, environmental engineering, K-12 outreach, materials engineering, mechanical engineering, metallurgical engineering, systems engineering, and social and environmental justice. Four of the faculty team members are in the Integrated Engineering department, one is in the Industrial and Systems Engineering department, and one works across the School of Engineering, and is not part of a specific department.

We are in the process of organizing our first interdisciplinary advisory board meeting. A variety of mechanisms are utilized to support the co-created solving of socio-technical problems, including community forums, community awards, scholar schemes, professional development events, a pro bono professional network, courses, capstone design projects, and research. We describe these mechanisms and respective activities to date in Table 1.

Table 1: Engineering Exchange for Social Justice (ExSJ) Mechanisms and Activities.

Mechanism	Description	Activities to Date
Community Forums	Thematic gatherings on a specified issue like "waste", where community groups, non-profits, engineers and other professionals, faculty, and students are brought together to exchange ideas and potentially form teams that may work together on future initiatives.	Hosted 2 community forums to bring various community and university stakeholders together around the theme of waste reduction. One was held on campus and the other in Los Laureles Canyon, Tijuana Mexico.
Community Awards	Funding to support community partners though project identification, framing and partnership initiation phases (Development Award), and to support project teams through the design, development, and installation phases (Seed-Fund).	Awarded 2 Development Awards ($500-$1,000) and two Seed-Fund Awards ($2,000-$5,000) to partnering community organizations to support the project defining and development phases, respectively.
Scholar Schemes	Recognizing and supporting the efforts of students, faculty and community partners who are already engaged in community-situated, socio-technical projects.	Conferred the year-long title of "ExSJ Scholar" on a first cohort in 2019 (8 students, 1 faculty member, 1 community partner) and a second cohort in 2020 (5 students, 2 faculty members).
Professional Development Events	Workshops and presentations that feature examples and best practices to support exchanges towards social /environmental justice and encourage and facilitate critical reflection on current practice.	Host 3 ExSJ Professional Development events per semester (ongoing), open to USD and the broader San Diego community. Events typically feature a speaker or a panel of speakers, followed by discussion/Q+A.
Pro Bono Professional Network	Professionals across all disciplines are invited to contribute their expertise, time and resources towards projects in support of communities, social and environmental justice.	Engagement through invitations to participate in ExSJ Professional Development events and Community Forums, as well as collaboration on ExSJ projects.
Courses	Series of engineering courses (new and previously in existence) that have been leveraged to facilitate the preparation of students for effectively engaging in community collaborations, and to connect students with community partners so they can participate in the project framing or development processes.	Engaging students in working alongside community partners to better understand the root causes of their identified socio-technical challenges & propose possible solutions (ENGR 103: User-Centered Design, ENGR 351: Community-Based Participatory Engineering Apprenticeship, ENGR 494 Engineering and Health).
Capstone Design Projects	Facilitating engineering capstone projects that develop and implement a proposed design solution to an identified socio-technical challenge.	Sponsored 10 social and environmental justice-related capstone design projects across engineering and computer science (2019-current).
Research	Supporting students in conducting research related to the ExSJ mission through independent study credits and summer research opportunities.	Supporting 2 students in research that will lay the foundation for upcoming ExSJ capstone projects. Hosted 2 visiting scholars.

Partnerships

Community partnerships are critical to the ExSJ. We are working to cultivate meaningful, long-term partnerships with a wide range of communities and organizations. Some examples of our established partnerships and the focus of our work include:

- *Advancing Students Forward* (ASF), partnering to develop a waste upcycling business with students from Colonia Tecolote in Mexico.
- *Blind Community Center of San Diego*, facilitating engagement between USD engineering students and low-vision or blind community members in user-centered engineering design courses.
- *Chula Vista Elementary School District*, partnering to facilitate the sustained STEM interest of Latinx middle schoolers.
- *Clear Blue Sea*, partnering to cleanse the oceans of plastic pollutants.
- *Division of Agriculture, Marine Affairs, Marketing and Environment* (DAMME) in Tobago, partnering to explore alternative energy solutions that can be used on small farms to power tasks such as irrigation and lights.
- *Laurel Tree Charter School*, partnering to implement sustainable energy infrastructure in the school.
- *Primo Energy*, partnering to power through wind and solar energy.
- *San Diego Mission Valley YMCA*, partnering to provide a summer enrichment program for incoming Montgomery Middle School students.
- *Tijuana River National Estuarine Research Reserve* (TRNERR), working on initiatives to protect the watershed by bringing value to waste up-stream and transparency to the state of water quality.
- *Twain High School*, partnering for the participation of pregnant and parenting teens in a USD interdisciplinary course, Creative Minds, that combines ways of thinking from theatre, mathematics and engineering, to create tools or manipulatives that can be used by young children to facilitate mathematical learning.
- *Viejas Band of the Kumeyaay Nation*, enabling USD engineering students and Kumeyaay children to exchange ideas, collaborate, and share cultural knowledge in their Science Technology Engineering Art and Math (STEAM) lab.
- *Waste for Life*, supporting communities to develop products from the waste they collect and create small community businesses.

Applying the ExSJ Framework

Challenges

Though we have presented the ExSJ framework in its idealistic and theoretical form, clearly its application is incredibly complex, messy, and wrought with challenges. This initiative is nascent, and we are learning as we go. We have begun to gain insights about student and community member engagement in the ExSJ through informal means as well as results from surveying and interviewing the first cohort of ExSJ scholars, awardees, and sponsored senior capstone design teams about their projects and conceptions of social justice in engineering. Emerging findings suggest that effectively communicating the values of exchange and socio-technical engineering to our students is not straightforward.

For example, students apply to become ExSJ Scholars, and in doing so answer questions about their socio-technical community engagement efforts. Although these students have taken one or two of the ExSJ courses (ENGR 103: User-Centered Design and ENGR 351: Community-Based Participatory Engineering Apprenticeship), and we know many of them are engaged in ExSJ-related work, we were struck by the difficulty they had in answering what we had considered simple application questions. We were similarly surprised by the uni-directional service mindset that was pervasive across the applications, despite having multiple experiences with the exchange paradigm. This observation highlights the entrenched dominant culture and the arduous process of changing culture and paradigms.

Sample Course Application of the ExSJ Framework

The ENGR 351: Community-Based Participatory Engineering Apprenticeship course is a seven-week intensive elective course co-taught by two members of the ExSJ Leadership Team. It is an interdisciplinary apprenticeship course to support engineers' ability to work with community groups around socio-technical problems. Explorations of the historical and contemporary contexts and impacts of designs, systems, processes, and products surrounding and involving engineering and engineers are applied to a community context. Students collaborate with communities to share knowledge and understanding and to co-create project briefs related to engineering in support of social justice.

In Spring 2019, the course involved partnership with the Viejas Band of the Kumeyaay Nation. USD engineering students and middle-school-aged Kumeyaay children exchanged ideas, collaborated, and shared cultural knowledge in the Kumeyaay Science Technology Engineering Art and Math (STEAM) lab as they worked together to co-define problems related to the Tijuana Estuary. The Tijuana River National Estuarine Research Reserve (TRNERR), the organization that conducts research, monitoring, education, and training designed to improve understanding and management of the estuary, is also a partner. The coming together of TRNERR, USD, and the Kumeyaay community yielded diverse impressions about one another and the work ahead from the various stakeholders:

> "At our first meeting with the students, I didn't understand why you were working with a Kumeyaay 'lens' on the problem. What about the Mexicans? Now I realize, and I feel very bad because I have forgotten our traditional people in the work that I do. I will change that now".
>
> -Tijuana (Mexican) representative for TRNERR

> "On my first visit, I described the Kumeyaay as individuals who were trying to victimize themselves in order to gain something from us. My damaged sense of empathy made me believe that their victimization was a tool for them to gain advantage. I was unable to recognize generational oppression. I discovered my character was shaped by apathetic, judgmental, and exclusive ideas. This class has awakened me. The most powerful realization was to discover the impact my actions have in many dimensions such as socioeconomic structure, systemic oppression and inclusivity."
>
> -USD Engineering Student

> "I sat listening to a lot of big words. And I went, Wow, okay. And I don't speak engineer, you know, each department has their own language and I don't speak engineering. So I sat there going, okay, I guess I hear what they're saying. I don't know what exactly that specific thing is they're talking about, and it seemed very… I don't mean this to sound mean, but it was there. I don't know how else to say this, other than it sounded very 'White' in thinking. Very linear. And I don't think that way as an indigenous woman. I think in circles, and I don't think in like a progressive line."
>
> -Kumeyaay community member

The brave vulnerability of these reflections allows for a window into the divergent perspectives and emotions churned when dealing in the authentic muck of the socio-, rife with marginalization, privilege, historical and cultural wounds, and beyond. They also highlight the critical nature of boldly venturing into the muck; the importance and challenge of intercommunity partnerships, exchange, and socio-technical approaches to advancing social and environmental justice.

Next Steps

Our next steps are to: 1) convene our interdisciplinary advisory board, 2) sustain, nurture, and deepen the partnerships we have created, 3) expand the ExSJ by forging new partnerships and initiatives, and supporting new collaborative community projects, and 4) continue to build on our funding-base by securing ongoing funding to sustain and advance the ExSJ. We are in the process of soliciting a range of funding from government grants, donors, and private foundations.

In 2021, in partnership with faculty from the Environmental and Ocean Sciences department at USD, we proposed the creation and launch of a new water-focused arm of the ExSJ called the Water Justice Exchange (WJE) for Strategic Initiative funding. Unlike the engineering housed ExSJ, the WJE would live outside engineering, and provide an inter-campus, inter-community synergistic exchange specifically focused on advancing understanding of and innovative solutions to our critical local (San Diego and Tijuana region) water justice challenges. The intent of the WJE is to foster collaborative multidisciplinary research, student experiential learning, policy creation (advocacy), and community projects at the nexus of water, social, and environmental justice in the region. If funded, the WJE will launch in fall of 2021.

Conclusions

The ExSJ supports the connection between engineering and social justice. Engineering as a profession can contribute to systems of injustice or be part of a systemic change towards social justice. However, those developing and enacting engineering projects, processes, and systems are rarely educated in the complexities of the local and global social/economic and political contexts in which they are working. Given a thoughtful education and working together—across disciplines and with community grassroots organizations—engineers can work to co-create just and ecologically sustainable socio-technical solutions.

The foundational values of the ExSJ framework can be applied to all engineering contexts, providing a platform for change that moves away from narrowly constructed and techno-centric epistemological approaches, and an expansion to engage social and environmental justice, humanitarian goals, peace, and sustainability through equitable partnership exchanges. Our hope

is that readers engage with the ExSJ as a lens through which to see the engineering practice, a framework for partnering ('exchanging') with communities, and a pathway to a more just and sustainable world.

Acknowledgements

This work was funded by the University of San Diego's Strategic Initiative program and by the National Science Foundation (NSF) grant #1519453. However, these contents do not necessarily represent the policies of NSF, and you should not assume endorsement by the federal government.

References

[1] National Academy of Engineering. (1991). Engineering as a Social Enterprise. The National Academies Press. https://doi.org/10.17226/1829

[2] Hoople, G., Choi-Fitzpatrick, A., & Reddy, E. (2018). Educating changemakers: Cross disciplinary collaboration between a school of engineering and a school of peace. 2018 IEEE Frontiers in Education Conference (FIE), 1–5.

[3] Lord, S. M., Mejia, J. A., Hoople, G., Chen, D., Dalrymple, O., Reddy, E., Przestrzelski, B., & Choi-Fitzpatrick, A. (2018). Creative Curricula for Changemaking Engineers. 2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC), 1–5.

[4] Lord, Susan M., Olson, R., Roberts, C. A., Baillie, C., Dalrymple, O. O., & Perry, L. A. (2020, June 22). Developing Changemaking Engineers – Year Five. https://peer.asee.org/34427

[5] Olson, R., Lord, S., Camacho, M., Huang, M., Perry, L., Przestrzelski, B., & Roberts, C. (2019). Developing Changemaking Engineers-Year Four. 2019 American Society for Engineering Education Annual Conference Proceedings.

[6] Olson, R., & Acero, A. (2018). Introducing changemaking engineering into an Operations Research course: Some unexpected results. ASEE Annual Conference Proceedings.

[7] Przestrzelski, B., Reddy, E., & Lord, S. M. (2018). Integrating Social with Technical:" Bring in your Trash module for a Materials Science Class. ASEE Annual Conference Proceedings.

[8] Reddy, E., Przestrzelski, B., Lord, S. M., & Khalil, I. (2018). Introducing social relevance and global context into the introduction to heat transfer course. ASEE Annual Conference Proceedings.

[9] Roberts, C. A., Olson, R., Lord, S. M., Camacho, M. M., Huang, M. Z., & Perry, L. A. (2017, June). Work In Progress: Developing Changemaking Engineers (Year 2). In 2017 ASEE Annual Conference & Exposition.

[10] Urias, E., Vogels, F., Yalcin, S., Malagrida, R., Steinhaus, N., & Zweekhorst, M. (2020). A framework for Science Shop processes: Results of a modified Delphi study. Futures, 123, 102613.

[11] Savoia, A., Lefebvre, B., Millot, G., & Bocquet, B. (2017). The science shop concept and its implementation in a French university. Journal of Innovation Economics Management, (1), 97-117.

[12] Hawkins, L., Mulder, H., & Steinhause, N. (2013). Building a Science or Research shop: Refining or Expanding Your Model.

[13] Baillie, C. (2020). Engineering and social justice. In The Routledge Handbook of Philosophy and Engineering. Routledge.

[14] Franklin, U., & Swenarchuk, M. (2006). The Ursula Franklin reader: Pacifism as a map. Between the Lines.

[15] Bielefeldt, A. R., & Lima, M. (2019). Service-learning and civic engagement as the basis for engineering design education. In New Innovations in Engineering Education and Naval Engineering. IntechOpen.

[16] Canney, N., & Bielefeldt, A. (2020). Collegiate service engagement correlations with engineering job selection and satisfaction. International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship, 15(1), 1-17.

[17] Bandyopadhyay, R. (2019). Volunteer tourism and “The White Man’s Burden”: globalization of suffering, white savior complex, religion and modernity. Journal of Sustainable Tourism, 27(3), 327-343.

[18] Momo, B., Hoople, G. D., Chen, D. A., Mejia, J. A., & Lord, S. M. (2020). Broadening the engineering canon: How Culturally Responsive Pedagogies can help educate the engineers of the future. Murmurations Emerg. Equity Educ, 2, 6-21.From Techno-centric to Socio-technical

[19] Baillie, Caroline, and George Catalano. 2009. Engineering and Society:Working Towards Social Justice, Part I: Engineering and Society. Morgan & Claypool.

[20] Riley, Donna. 2008. Engineering and social justice. Morgan & Claypool Publishers.

[21] Leydens, Jon A., and Juan C. Lucena. 2017. Engineering justice: Transforming engineering education and practice. John Wiley & Sons.

[22] Kimmerer, R. W. (2013). Braiding sweetgrass: Indigenous wisdom, scientific knowledge and the teachings of plants. Milkweed Editions.

[23] Watson, J. (2019). Lo-Tek: design by radical indigenism. Taschen.

[24] Riley, Donna. 2017. “Rigor/Us: Building boundaries and disciplining diversity with standards of merit.” Engineering Studies 9 (3): 249–265.