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Pathways from Engineering Programs to Labor Unions

Dr. Joey Valle, Purdue University

Joseph 'Joey' Valle is a queer Latine Ashkenazi Jew employed as a postdoctoral worker in the School of Engineering Education at Purdue University. Dr. Valle received a Ph.D in Materials Science and Engineering at the University of Michigan - Ann Arbor. They were awarded an NSF STEMEdIPRF Postdoctoral Fellowship: Advancing Engineering Education in Universities on Labor and Unions to study intersections of engineering and labor.

Lazlo Stepback, Purdue University

Lazlo Stepback is a PhD student in Engineering Education at Purdue University. His current research interests focus on engineering ethics, the connections between personal morals and professional ethics, and how students ethically develop as engineers. He earned a B.S. in Chemical and Biochemical Engineering at the Colorado School of Mines (Golden, CO) in 2020.

Polly Parkinson, Utah State University
Fawn Groves, Utah State University
Dr. Angela Minichiello, Utah State University

Angela (Angie) Minichiello is a military veteran, licensed mechanical engineer, and associate professor in the Department of Engineering Education at Utah State University. Her research examines issues of access, equity, and identity in the formation of engineers and a diverse, transdisciplinary 21st century engineering workforce. Angie received an NSF CAREER award in 2021 for her work with student veterans and service members in engineering.

Dr. Matthew W. Ohland, Purdue University

Matthew W. Ohland is the Dale and Suzi Gallagher Professor and Associate Head of Engineering Education at Purdue University. He has degrees from Swarthmore College, Rensselaer Polytechnic Institute, and the University of Florida. His research on the longitudinal study of engineering students and forming and managing teams has been supported by the National Science Foundation and the Sloan Foundation and his team received for the best paper published in the Journal of Engineering Education in 2008, 2011, and 2019 and from the IEEE Transactions on Education in 2011 and 2015. Dr. Ohland is an ABET Program Evaluator for ASEE and represents ASEE on the Engineering Accreditation Commission. He was the 2002–2006 President of Tau Beta Pi and is a Fellow of the ASEE, IEEE, and AAAS. He was inducted into the ASEE Hall of Fame in 2023.

Pathways From Engineering Programs to Labor Unions

Abstract:

According to the United States Bureau of Labor Statistics, union density amongst engineering workers within the US hovers around 7%. Despite hundreds of thousands of US engineers participating in the labor movement, engineering education on labor unions has been virtually non-existent within US higher education engineering programs. US higher education engineering programs are critical junctures in the making of engineers that have long histories of ensnarement by corporate industries with vested interests in undermining organized labor. This stark and significant absence of labor education coupled with decades-long denunciations that many engineering professional societies have made to discourage participation of engineers in building labor unions and the labor movement interrupt engineers' capacity to collectively leverage our power for safer, healthier, and more just workplaces and worlds. An imperative task in the (re)development of the US engineering workforce is to build and strengthen union density amongst engineers by expanding unionization pathways.

This paper offers a preliminary report back on a broader engineering workforce development project to nurture relationships between an unorganized (i.e. non-union) engineering research center and organized labor. Herein, we uplift stories from union members describing their pathways from higher education engineering programs to labor unions. Group interview conversations illuminating these stories offer broader contextualization for the sparseness and rarity of the paths from engineering programs to labor unions. Dialogue from group interviews further pointed toward opportunities to expand unionization pathways for engineering workers.

Background:

Engineers, as a set of workers whose technical knowledge and expertise are vital to industrial production and state power, occupy an important nexus of power in the modern social system [1]. Throughout its history in the United States, the occupation-turned-profession of engineering has grown and expanded in service to a state and the multinational corporations it leverages its monopoly on violence to protect, as numerous scholars have named (see for example [1-3]). Overwhelmingly, US engineers are trained to accept and uphold an ideology of business professionalism that situates engineers as rightly beholden to the whims of capitalists helming multinational corporations and industries employing engineers [4]; [5]. This acts to discipline engineers and restrict the legitimized forms of social organization engineers engage in largely to those which reproduce business professionalism: the corporation, state bureaucracy, academia, and the professional society. Such business professionalism frames unionism as inherently unprofessional as a means of dissuading engineers from unionizing despite the power unionization offers for systemic transformation [6]. Throughout their histories, engineering professional societies have been notorious for being strongly influenced or directly controlled by industry via an overwhelmingly white male engineering-manager class. This relationship forged between engineering and industry has served to reinforce the ideology of business professionalism that inherently has been particularly hostile to labor unions, organizing, and anti-capitalist theories of change [2]; [4]; [6-8]. Major's description of being asked by 2018 Frontiers

in Education (FIE) conference organizers to cross the picket line and "ignore the strike" authorized by nearly 99% of Unite Here hotel workers at the San Jose Mariott FIE conference venue offers a tangible example of how engineering professional societies push their members to side with employers [9]; [10]. As Zussman succinctly names, "for corporate management and for most engineering societies, the possibility [of unionizing engineers] represents a threat to engineering professionalism," [7, p. 160]. We argue that engineering education can and should be transformed to actualize that possibility.

A core component of the professionalization process of engineers occurs within engineering colleges or universities. As Lasch writes in the foreword to David Noble's *America By Design,* "the professionalization of engineering and the establishment of engineering education as a recognized branch of higher learning forged a link between the corporation and the university that remains unbroken to this day," [11]. It has been well documented that engineering college and university programs significantly constrains sociopolitical understandings amongst engineering students through a focus on technical education to meet the demands of industry (see for example [1]; [3]; [12]; [13]; [14]). One element of this touched on within the group interviews presented here is a significant absence of labor education and in turn, the relative rarity of unionized engineers and low class consciousness. This hegemonic adherence to business professionalism is reflected in how Pawley has described the continual reproduction of an engineering education and workforce development that serves to

> "indoctrinate students into neoliberalism as the only possible mode of economic development. Their job will be to work in an industrial machine; we do not articulate alternative modes of thought or help students develop cognitive lenses to conceive of a way of being outside this neoliberal worldview" [13, p. 449].

An imperative task in the (re)development of the US engineering workforce is to transform the consciousness of those who take on the title of engineer to break away from the continued ideological imposition of business professionalism. In turn, rather than continuing the violence enacted to build up corporations and industry, moving to build life-affirming institutions oriented toward a transition away from the dominant social order and the hierarchies placed on human difference inherent therein. As institutions workers build to collectively improve their living and working conditions, labor unions can and have acted as key sites for education, consciousness raising, and power building collective action towards such ends. Labor unions exist in contexts where workers do not own the means of production (instruments and resources designed to produce goods in a society), such as the in large corporations, academies, state bureaucracies, and organizations that most US engineers find employment in. As numerous group interviewees remarked, safety is at the core of labor unions. Aligned with the engineering and labor theory of change posited by Valle, Bowen, and Riley, we consider strengthening union density amongst engineers and expanding unionization pathways for engineering workers to hold significant potential for accomplishing this task [5]. Valle, Bowen, and Riley forefront an understanding that the identity 'engineer' is fundamentally rooted in forms of labor that are essential to the continuation of US industry and the state, that engineers and their educators are workers capable of organizing for liberatory systemic transformation, and that radical labor unions are important

institutions engineers can build for consciousness raising and harnessing power to undermine the foundations of the dominant and dominating social order.

In the US, unionization rates amongst engineers hover roughly at 7% [15]. This is down from a historical high of roughly 10% in the late 1940s-late 1950s. This period of unionization was largely spurred by engineering workers forming separate unions at their worksites to avoid incorporation into larger, more class struggle oriented industrial unions comprised mostly of 'blue-collar' workers that engineers considered beneath them [2]; [7]; [16]. Zussman describes the orientations of such engineering unions as "primarily defensive, essential[ly] antiunion," owing to the professional status they sought to maintain distancing them from the broader labor movement [7, p. 164].

The theory of structural contingency offered by Meiksins and Smith gives insight into the difficulty of unionizing engineering workers in the US as well as the relatively conservative orientations of engineering unions [6]. Taking a comparative approach to the unionization of engineers in the US and Great Britain, they reject the business professional notion advanced by many engineering professional societies in both states that professionalism and unionism are incompatible. They instead contend that structural forces exist within all industrial capitalist societies that exert pressure for engineers to unionize, however the degree to which these pressures align to unionize engineers is dependent upon the conditions specific to that national context. In *Why American Engineers Aren't Unionized - A Comparative Perspective* [6], they identify five factors shaping the unionization of engineers in industrial societies and the conditions in the US context:

1. **Concern with status** – Primary amongst the factors, the meritocratic ideology has driven US engineers to construct and maintain a status hierarchically below industrial owners and above 'non-professional' workers and the related 'blue-collar' labor movement more broadly.
2. **Business professionalism** – The brand of professionalism asserting the *rightful* dominance of industrial owners over engineers. This has largely taken hold in engineering through wealthy, white, male engineer-managers with close ties to industry owners exerting control over state apparatuses, engineering academies, and professional societies. Business professionalism has been made the official ideology of the organized engineering profession, one which reproduces a culture of disengagement. This focuses efforts toward individual careers and upward mobility in corporate hierarchies rather than collective or systemic change toward safer, healthier, and more just workplaces and worlds.
3. **Engineers' societal status and timing of unionization** – US engineers nominally enjoy a high societal status owing to their associations with business and technology that are both highly valued in US society. Initially in the mid-19th century the middle- to upper-class, white, male engineers that dominated the occupation leveraged their influence in the state, corporations, and academies to organize engineers into management and professional societies rather than labor unions. They did so largely for individual rather

than collective benefit, contorting the infrastructure of recruitment, organization, and education of engineers thereafter.

4. **Attitude of the labor movement toward engineers** – There has not been a sustained interest within the US labor movement in organizing professional employees generally and engineers particularly.

5. **Climate for union organization** – The US is overwhelmingly hostile to labor organizing, especially relative to other industrial capitalist states.

It is in this broader US context of misinformation, disinformation, and hostility toward labor organizing in engineering and engineering education that we, a team of unorganized workers tasked with engineering workforce development in an NSF engineering research center, have sought to build relationships with organized labor. Initially some of this misinformation has manifested within the center as disbelief that connecting with existing labor unions has any bearing on the engineering-oriented work of the center, dismissal of labor education as meaningful, much less necessary, for engineering students, and relegating labor unions as institutions solely for 'blue-collar' trades workers that engineers may interact with in their work instead of institutions for engineers to join and build themselves. Structurally, we also contend with the more explicit business professional center goals of courting industry and state partners and drawing on state power to strengthening connections between higher education institutions and industry, noting how these reflect the very orientations we seek to move away from.

In this paper, we offer a report back from a set of group interviews conducted with unionized non-engineering workers from a variety of crafts and industries across a state in which one of the center's campuses is located. The focus groups were oriented around the educational pathways of workers, impacts technological changes in a field relevant to the center may have on the future of their work, obstacles keeping workers from meaningful and sustaining work, worker interactions with engineering workers, and the unionization of engineers.

Method:

The research team employed the methodological approach known as engaged scholarship to conceive of and guide this study related to labor organizations, the future of unionized work, and the intersections between unionized labor and the work of the engineering research center [17]; [18]. Engaged scholarship is a "collaborative form of inquiry" [19] in which researchers "are involved, collaborate, negotiate, develop trust and coproduce knowledge with members of the organizations over issues that are of concern to the organization" [20, p. 2]. Developed within the applied disciplines of organizational theory and project management, engaged scholarship requires researchers to cooperatively interact with practitioner-stakeholders to identify, understand, and improve upon "complex social problems that often exceed our limited capabilities [as researchers] to study on our own" [18, p. 37]. Organizational engaged scholarship has been likened to design-based research in education, wherein education researchers team up with a variety of education practitioner-stakeholders to iteratively advance the theory and design of an intervention to a complex educational problem, and is considered useful for researchers seeking to advance both scientific and practical knowledge together [17]; [20].

Participants. The research team used convenience sampling to recruit participants for focus group interviews from a group of union members who were previously scheduled to tour center facilities at one if its university campuses [21]. Using procedures established by two approved IRB protocols, one researcher who is located at the campus where the tour was taking place worked with the center employee who was managing the tour to send out an electronic survey using Qualtrics to all union members who had signed up to take part in the campus visit. The electronic survey introduced the study. If union members selected YES that they wanted to participate in the study and then provided their name and email and signed the informed consent provided within the survey, they were entered into the study as participants and asked to complete seven demographic questions and one interest-related question. The interest-related question required participants to rank order their interest in four focus group topic areas that were collaboratively developed by the research team:

a) the future of work in electrified transportation,
b) tackling obstacles between workers and electrified transportation jobs,
c) on the job interactions with engineers and engineering workers, and
d) engineering workforce unionization.

The researchers used the participants responses to the interest-related question to pre-select participants into one of four focus groups.

Overall, 30 union members responded YES to enter the study, completed the informed consent information, and were entered into the study as participants. For questions about race and gender, participants were asked to write in their identities. The vast majority of participants identified as white males. Of these 30 participants, 24 identified their race as "w/White" or "Caucasian", one identified as "Native American and Caucasian", one identified as "Ginger", and four did not identify their race. Three participants identified their gender as "Female", 26 identified as "m/Male" or "m", and two participants did not respond. In response to the question "Are you Hispanic/Latinx?", 28 participants selected "No" and two participants did not respond. Three participants identified as a veteran, having served but no longer serving, and one participant identified as a military spouse/partner. No participants identified as having a disability.

Data Generation. Prior to conducting the focus group interviews, the research team toured campus facilities with the participants and joined the participants for a delivered, "picnic tables" lunch held outside of the university conference center located on campus. Having lunch and touring facilities together helped develop rapport between the researchers and participants. The four focus group interviews were conducted in individual private rooms located within the university conference center. Once lunch was complete, participants were given the number corresponding to their focus group (i.e., 1, 2, 3, or 4) that they had been selected into based on their responses to the interest survey question. Participants then proceeded into the conference center and to the conference room marked with the same number. We note that not all participants who volunteered for the study and were assigned a focus group came to the interviews.

Each focus group interview was led by one member of the research team. Focus group protocols and questions for each group had been previously developed by the research team. Each focus group interview was audio (only) recorded using two handheld recorders (i.e., one main and one backup). At the conclusion of each interview, participants left the building to return home on their own. At the conclusion of all interviews, the recorders were collected by one member of the research team who was responsible for downloading and verifying the recordings; uploading the recordings to a secure folder on BOX, an encrypted cloud-based storage system; deleting the audio recordings from the recording devices; and providing the rest of the research team access to the secure BOX folder.

Coding process. Audio recordings of interviews were transcribed by one member of the research team into the secure BOX folder. Inductive coding was conducted by two members of the research team in two rounds with a focus toward the intersections of labor and engineering using N-Vivo coding software. In the first-round researchers independently developed codes, after which codes were compared and both researchers reviewed the interview transcriptions for the second-round of coding. Initial themes at the intersections of labor and engineering stemming from this coding are reported below.

Findings and discussion:

Paths from engineering schools to labor unions

Two workers spoke of going through engineering programs at higher education institutions prior to joining their unions. Neither of the workers offered any mention of education regarding labor unions in their engineering programs. Instead, they drew from prior knowledge about labor unions to influence their paths. As the first worker in the communications field describes,

> "I have an applied bachelor's degree in electrical engineering. ... I wanted to get an engineering position over at [an electronics manufacturer] and they wanted me for the position … So they basically were offering me about the same amount of money that [my current employer] was offering me and I knew that [my current employer] was union, so I went to [my current employer], because I wasn't gonna be begging the rest of my career for money ... not getting a full engineering title. Just get a … junior assistant, junior engineer, whatever it was [at the electronics manufacturer]. I just figured that I would be stuck at that title the rest of my life. And I didn't want to do that. So, I went to [my current employer] and that's how I got into the union. Yeah, and then recently I got elected as our president for our local, so I'm in there." - *unionized communications worker*

This unionized communications worker describes how a combination of money, status, and the presence of a union at his potential worksite were the primary influences on where he decided to work after completing his electrical engineering degree program. He was offered comparable levels of pay at both options, but knew that the unionized position offered a greater opportunity to organize for higher pay through collective bargaining with his employer as opposed to begging his employer for raises in a non-unionized position. Relatedly he did not see the potential for promotion into a higher status engineering title at the non-unionized employer,

instead opting for a non-engineering position at a unionized worksite. Rather than seeking promotion from his employer, he discussed how his participation in his labor union drove his fellow workers to elect him president of their local (a local branch of a larger, typically national or international, labor union). It is meaningful for engineering educators to consider how many more engineering students-turned-workers would follow similar paths if labor education were more prevalent in engineering programs.

The second worker, a unionized electrician, describes how,

> "I had a wild idea to start my high school years to be an electrical engineer and I went to one year of engineering school at [an R1 institution]. … My parents had a very … they were both union, so I knew, I knew the union way of life. Then I went to community college and got 2 associates degrees, one in electricity, one in implementation process control. Then I got in the [electricians' union] apprenticeship program. I went through a 5-year apprenticeship program and then I graduated. I had enough general ed, so that's another associate's degree. ... By the end of my career I was an apprenticeship instructor for about almost 9 years. … I always wanted to be an electrician, like I said I got this swell idea that I was going to be an engineer and make twice as much money [as an electrician], got into engineering and didn't really like it so I kinda reverted back to my roots, but I had kind of a guide as my [unionized electrician] brother." - *unionized electrician*

This unionized electrician described how he sought engineering as a means of making more money than he thought he could make as an electrician, despite always wanting to be an electrician. It is a truism that students often enter into engineering programs to obtain high salary employment upon graduation, as this unionized electrician sought. Upon completing a year of higher education in an electrical engineering program, he found that he didn't like it and that the prospect of higher pay with an electrical engineering degree was not significant enough to sustain his enrollment in the program. Instead, he transitioned to related associate degree programs at a community college before enrolling in the electricians' union apprenticeship program. His choice to obtain three associates degrees and instruct union apprentices for 9 years indicates that he was not averse to higher education, but to the conditions of the engineering program related to his line of work. He described how his parents and brother were unionized workers ('being union'), and the education around the 'union way of life' those familial ties offered helped him to transition away from an engineering school and to a union apprenticeship program.

Labor unions have a strong emphasis on health and safety

Across group interviews, participants discussed the strong emphasis on health and safety within labor unions. As a mandatory subject of bargaining, labor unions enable workers to collectively improve the health and safety conditions they labor under. Signifying the value placed on safety throughout union apprenticeship programs, a unionized electrician described how

> "safety was the founding principle of [our union]. And ... how we mitigated [hazards] is our apprenticeship training. I mean, training qualified people to be able to mitigate those

hazards is what we're founded on and qualified people doing the work ... that's our biggest concern with this type of [electrical] work is not only making sure that the work goes in correctly the first time, but if the work goes in correctly, that means the work is also put in safely" - *unionized electrician*

This unionized electrician describes the union apprenticeship program as a key site for training apprentice electricians in how to mitigate and navigate hazards inherent to electrical systems. He described safety here not only in terms of worker safety, but also system safety through the quality of work.

The same unionized electrician went on to describe how

"there's a number of people that, you know, they're pushing for anti-licensing and they, they seem to have this mentality of you know, 'let's just go to a buyer beware [model].' In our industry, buyer beware … by the time you see the smoke, you know, it's too late. Either, you might have lost personnel or you might have lost property or both. Yeah, and so I think, just educating people on that and, and making sure that we maintain our standards. It's kind of a common practice that any time and there's a lack of labor, then it seems to be this, this general rule of 'oh, we've got to cut regulation.'" - *unionized electrician*

In tandem with the apprenticeship programs, this unionized electrician discussed how state licensure offers a degree of safety for workers and the public by setting minimum training standards for electrical work. They also discuss how this degree of safety is precarious and can be weakened or removed by the state when there is a shortage of licensed workers relative to industry demand. In addition to offering a greater degree of safety compared to deregulation, licensure can act as a means for a category of workers to achieve significant control over their own labor and restrict the supply of labor [6]. As Meiksins and Smith describe within engineering, industry employers and executives have leveraged their dominant position within engineering professional societies and other engineering associations to discourage limitations to their use of and control over engineering labor through means such as licensure. Even the professional society that acts as the arbiter of professional engineering licensure, the National Society of Professional Engineers (NSPE), has been careful to maintain a business professional orientation so as to prevent licensure from limiting the control industry employers have over engineering workers.

Related to the precarity anti-worker state laws can bring, a unionized plumber pipefitter cited a 2018 study by Zoorob investigating impacts of state 'right-to-work' laws on occupational health and safety that he shares with apprentices he instructs [22]. He describes how

"for a 1% drop in union membership, there is a 5% increase in job fatalities, which is pretty staggering and that's because through our apprenticeship, we train them in safety first and they learn how to do the job safely and then, also on the job, when they see something unsafe they know how to collectively work together to make it safe. So, I think that's a huge benefit of using unions, for sure." - *unionized plumber pipefitter*

This unionized plumber pipefitter describes the impact workers joining together in labor unions has on keeping workers alive. Zoorob has identified at least a 14% increase in workplace mortality from 1992 to 2016 attributable to state right-to-work laws designed to decrease union membership and degrade union power [22]. Notably, engineering professional societies such as the NSPE have lobbied states to pass right-to-work laws (see for example [23]). The apprenticeship program plumber pipefitters are educated through emphasizes safety, including ways to leverage collective power workers have to avoid unsafe working conditions. The same cannot be said for ununionized plumber pipefitters who do not go through union apprenticeship programs and are less able to collectively refuse hazardous working conditions.

A unionized equipment operator described how the emphasis unions place on safety was operationalized at their worksite to avoid hazardous working conditions

> "[Management was] gonna run one [large piece of equipment] while they were working on the other [large piece of equipment] and they got with some of the [emergency medical technicians] team members and the emergency response manager for our facility and then some of the union leaders and we have a lot of robust talks about that. And at the end of the day, it basically fell on personnel safety and, there was no way that we felt that there could only be one access and exit point out of the [large piece of equipment] that they were working on and be able to run the other [large piece of equipment] and if there was a catastrophic emergency then we're looking at loss of life." - *unionized equipment operator*

While management had the inclination to run one piece of equipment while another was undergoing repairs in order to reduce profit loss, workers were able to avoid the hazards working under such conditions would bring by focusing on personnel safety to shifting the decision of management.

Conditions shaping paths from engineering schools to labor unions

In the group interviews, unionized workers shared a number of stories and raised a number of issues that offer insight into conditions that rarefy paths from engineering schools to labor unions. Particularly misinformation or disinformation regarding labor unions, engineers seeking to reinforce their perceived hierarchical status above 'blue-collar' or 'non-professional' workers, and disconnections of engineering workers from on the ground conditions.

A lack of information, misinformation, or disinformation regarding labor unions

Speaking to the anti-union sentiments of corporate owners, a unionized construction worker described that

> "there's people above the engineers that don't want them to unionize, so the less they know about it, the more it is about them. Because if you can have a group of individuals and keep them individuals then you have control over them." - *unionized construction worker*

US employers have been notoriously hostile to labor unions, increasingly so after the passage of the Taft-Hartley Act formally legalized active employer opposition to labor unions rather than neutrality [6]. It has been well documented that engineering professional societies, including ASEE, lobbied for the passage of the Taft-Hartley Act, particularly to include the Professional Provision drafted by engineering professional societies that asserted engineers can carve themselves out of primarily non-professional industrial union bargaining units [6]; [7]; [23]. The divide and conquer tactic of individualization, as this unionized construction worker points out, has been a key ideological means for corporate owners to control and diminish the collective power of workers. Cech has discussed how such individualization takes the form of a culturally hegemonic ideology of meritocracy amongst US engineers, wherein inequity is justified by a belief that success in life is the result of individual talent, training, and motivation [24]. Meritocratic beliefs meld with ideological business professionalism to rationalize, justify, and normalize the control corporate owners exert over engineering workers, underpinning the concern with status amongst engineers that has been a large inhibitor toward unionization [6].

Beyond the anti-union sentiments of corporate owners, a unionized laborer described how

> "[Most] of the state is not on the same page as us. When only [a small minority] of the state is unionized there's a lot of ... If there's any information at all, it's misinformation, whatever you're getting fed from maybe some big media things, but nothing actually translates or is relevant for how the unions in [this state] do have to function." - *unionized laborer*

As Meiksins and Smith have noted, the conditions in the US are overwhelmingly inhospitable to labor organizing compared to other industrial capitalist states [6]. Such conditions leave many workers, including engineers, with remarkably little labor education. Disinformation and misinformation regarding labor unions are components of this inhospitable labor climate. Disinformation is a deliberate spreading of misleading information while misinformation is propagating incorrect or misleading information in ways that are not necessarily deliberate. Numerous companies, particularly the kind of multinational corporations engineers often find employment in, seek to bolster anti-union campaigns with assistance from an unabashedly anti-union 'union avoidance' industry that has ballooned in the US since the 1970s [25]. Logan describes a variety of means by which union avoidance firms seek to propagate disinformation amongst workers regarding labor unions, with some of the "standard features of modern union avoidance campaigns, including customized videos and web sites, 'vote no' committees, and campaign literature stressing the alleged futility of, and risks associated with, unionization," [25, p. 653]. Engineering professional societies such as NSPE have acted similar to union avoidance firms by sewing disinformation amongst engineering workers to hinder engineering unionization drives, remove engineers from larger industrial bargaining units, and decertify engineering unions [23]. Relatedly, Martin writes of the notable shift of mainstream media away from labor and towards business interests since the late 1960s that contributes to the spread of misinformation about labor unions and the broader labor movement touched on by this unionized laborer [26].

Aligning with the previous comment by the unionized laborer about a lack of information, a unionized operating engineer described how he became educated about labor unions

> "Honestly in the little town I grew up in there's 2 gravel pits in the mouth of the canyon. One on one side of the roads non-union and one on the other sides union. Okay, I put in my application on both, both of them and the union, union side hired me; but I until then, I … had never …. I didn't know anything about unions. I'd worked construction and if you take a break or you're not packing enough forms or whatever that you know [the boss would say]: 'this ain't a union job,' you know, or whatever. (laughs) That's the only thing I knew about it. Yeah, I just got out of the gravel pit as soon as I could and I went to the shop and start being a steward there and then moved on to work for the [union] hall itself as an organizer. Simple, easy, but I didn't know anything about unions. I love it now! And I preach it every day, but I didn't know nothing then." - *unionized operating engineer*

This unionized operating engineer describes how some of his initial education regarding labor unions came in the form of misinformation from his boss. Playing off of meritocratic beliefs of work pervasive in US culture, the boss put forward an association of being lazy or underperforming with labor unions when the worker took a break. Such associations are standard in union avoidance campaigns and is reflected in the business professional view of "unionism as a measure of mediocrity," [2, p. 42; 25]. Seeing through this once he was hired into a unionized worksite, he described how he quickly moved into an organizing role within his union as a shop steward and then an organizer in his local. The experiential education he received of being in union moved him from being uninformed regarding unions to enthusiastically and actively educating others about unions.

A unionized educator described some of her familial context and misinformation she received regarding labor unions

> "I went in [to my worksite] not knowing a lot about unions. My grandfather was a railroader. He did post office kinds of railroad stuff. He was a union man, but he died when I was really young. And my family was kind of like: 'unions, you don't need them anymore, they're just no big deal. Don't mess with them' … and then I started dating [a unionized worker] and he kind of enlightened me to what unions really were and it was like, eye opening … like this makes a lot more sense than what I got brought up being told." - *unionized educator*

She describes her grandfather being a union man, however since he died when she was young she was unable to learn much about unions or the 'union way of life,' mentioned previously by an electrician, from him. Instead, she was brought up on misinformed perspectives that quickly fell apart once she began dating a unionized worker. That unionized worker offered her clarity around the value and meaning of labor unions, providing her with an understanding that better matched with her lived experience than the misinformation regarding labor unions offered her by her family. It is meaningful for engineering educators to consider how labor education could

similarly benefit engineering students, especially within the deeply constrained conditions for cultivating sociopolitical understandings that exist in engineering programs.

A unionized postal worker discussed some of what attracted him to his union

> "I didn't know what a union was until Bon Jovi told me 'unions on strike' (laughs). That's all I knew about unions. (laughs). And when I got into the postal service, they have negotiated contracts and I said 'what? What!?!' And they went 'here': and look up all of the rules that not only I'm supposed to follow, but management is supposed to follow. And that's what got me hooked in, because management was not following it and I am the one that will speak up for: 'You're doing it wrong.' And the union has been awesome for me and my family." - *unionized postal worker*

This unionized postal worker discusses how his initial education regarding labor unions came in the form of a song lyric about a union on strike. As one of the most tangible displays of power a union can decide to engage in, workers choosing to collectively withhold labor, I.e. striking, is a labor action most frequently represented in media. Less pervasive is the reason workers strike companies, which often occurs to secure better working and living conditions for the workers, their families, and their communities into a collective bargaining agreement. As this unionized postal worker learned, and what attracted him to labor unions, was that a component of the working conditions covered in collective bargaining agreements is limitations on what employers and management can do, I.e. the rules management must follow. In turn, when management violates the terms of the collective bargaining agreement workers can act to push them back in line with the agreement, as he describes he now does at his worksite. Despite sometimes being framed as alternatives to labor unions, professional societies are structurally incapable of offering the sort of limitations on employers and management that can be found in a labor union's collective bargaining agreement with their employer [6].

Engineers' status reinforcing hierarchy and disconnection from on the ground conditions

Pervasive in analyses of engineering labor in the US is an assertion that engineers maintain a professional status hierarchically above the kind of 'non-professional' workers who participated in these group interviews (see for example [2]; [6-8]). Interactions the workers described they had with engineers demonstrate negative impacts of this separation. For example, a unionized equipment operator describes how

> "In my daily process I deal with engineers, production engineers and chemical engineers frequently and it is my finding that they're not listening to the people that, as my company touts them, [are] 'the subject matter experts,' because if you say 'if we do it this way it will run better,' then chances are they're gonna do it the opposite way (laughs). And whether it's because they see value in what you have to say or they have a predestined thing that they want to do or they want to try to accomplish, that they're just going to run it that way ... and you talk to them about it and they still disregard what you have to say. After a while you pretty much just quit talking to them and be like, 'hey, whatever you throw at me, I'll just take care of.'" - *unionized equipment operator*

While, as a unionized educator asserted, "union members and union workers are absolute experts in their field and they need to be treated as experts," the engineers this unionized equipment operator works with fail to recognize his and his fellow union members expertise. Ozkan, Fried, and Rosenberg describe how, in the offshore wind industry, unionized workers are isolated from the design process engineers work through and thus do not have an opportunity to remove hazards such designs produce [27]. Here, we see a similar case where the predetermined ideas of how the engineers seek to accomplish something ignore expertise of the unionized workers who would enact them. The hierarchical status bolstered by business professionalism maintains a distance between categories of workers that allows engineers to disregard meaningful input from those such as the equipment operators they consider beneath them and in turn, these workers can be put into precarious situations.

Relatedly, a unionized operating engineer described how

> "Engineers don't realize what it takes to put it to the ground. … I mean, they're very talented at what they do, but they're focused on how to make this piece work, not … And then you got a whole group of them making the entire piece work and then nobody has an idea of how to put it in the ground." - *unionized operating engineer*

Here, this unionized operating engineer describes the highly divided labor engineers engage in and how that division disconnects them from expertise required to materialize their designs. Zussman describes how engineering itself was largely created out of the separation of mental and manual labor which proletarianized craftsmen and de-skills 'blue-collar' workers while transferring mental labor, which was valued higher than manual labor, to engineers [7]. The corporate division of labor also came with a high degree of specialization for engineers which emphasizes optimizing a small piece within a broader system, abstracting the work and limiting interconnections across the broader system.

Speaking to the communication across groups, a unionized firefighter raised how

> "I think the biggest issue that I always see, and it doesn't matter what trade or what industries, you have the thinkers who then go to the engineers and say 'this is what I want done' and the engineers can say on paper this is what it looks like, this is what it should do, this is how it should work. But a lot of times it never makes it down to the guy that's actually gonna build it to make sure that it actually is gonna work. And so just like with everything else, I think sometimes communication stinks. From the different levels." - *unionized firefighter*

This unionized firefighter highlighted the hierarchical ordering of work under capitalism. Profit seeking corporate executives generate a set of conditions and articulate a social vision that serve as the basis of the designs engineers produce. The produced designs are then transferred to other workers for implementation, as discussed above generally with minimal opportunities for those lower in the hierarchy to intervene on the actions of those situated above them even when such actions place them in precarious or hazardous conditions.

Labor Education for Engineers

Workers also had an opportunity to share their thoughts on educating engineers about labor and unions. A unionized educator described that

> "I'd like to see engineers educate themselves on what unions actually are, especially here in [this state]. The problem is most people don't even actually understand what a union is. In fact, we have members that don't even actually understand what a union is and it's frustrating, you know, and I think we've done a, our local, we've done a good job of actually trying to get out and help better educate our own members, but I think if, you know, the engineers were willing to go out to, you know, different training sites, different trades, there's people that would be willing to teach them and train them and help them understand more of what a union actually is. And that's what I'd like engineers to see. And again ... it takes everybody to make this work and that's what a union is about." - *unionized educator*

This unionized educator described misinformation about labor unions even amongst some members in his own union. He described a need for engineers to take initiative in exposing themselves to various settings and scenarios wherein they interact more with unionized workers. He describes doing so as a means for engineers to learn about what a union is. He also emphasized the collectivist orientation of labor unions, which stands counter to the individualism of engineering business professionalism and meritocracy. In some ways this educator placing the onus on engineers to proactively seek such education that runs counter to the hegemonic ideology of the profession reflects how the labor movement has not held a sustained interest in organizing engineers that Meiksins & Smith have noted as a factor as to why most engineers are not yet organized [6]. At the same time, there is an onus placed on engineering educators to catalyze engineers taking such initiative through labor education. Given the disgraceful history of US engineering education professional society ASEE and its predecessor SPEE largely serving to reinforce business professionalism, labor education amongst engineering educators has been suppressed and is relatively diffuse [2, 23]. Some of acting to change that can take the form of engineering educators ourselves unionizing our worksites and participating in the broader labor movement. That would provide more engineering educators with the experiential knowledge of being in union that can serve as a basis to draw from. It can also take the form of, as this educator described, engineering educators setting up visits to different training sites and trades for engineering students to learn from and cultivate relationships with unionized workers.

Speaking to the role of existing labor unions, a unionized laborer noted that

> "you can't do anything you don't know anything about, so it takes a proactive measure on our part [as union members and organizers] as well to make sure we're sharing this information even in areas and sources that we think it might not even need be discussed, because that's not our focus, this person is not going to come work for us so I'm not going to exert my time here with this conversation of educating them, but in the grand scheme of things of just saturating the entire state with information, we should be having these conversations with people in those places [like engineering] as well ... I feel like the unions in our state are going in a direction that's not receding, we're growing, we're

getting more strength. So as that continues, I would hope that the engineers at some point would be proactive and seeking that out, right?" - *unionized laborer*

This unionized laborer discussed a need for existing unions to educate non-unionized workers beyond those in their own sector of work. Highlighting conditions particularly prevalent amongst engineering workers, that many workers are uninformed or misinformed regarding labor unions especially owing to the disinformation propagated in engineering programs and by engineering professional societies, positions existing union members and organizers as educators for their non-unionized siblings. Extending labor education beyond their direct sectors of work offers a means to catalyze worker organizing in other sectors, such as engineering, and growing the strength of the labor movement. He too spoke to the need for engineers to be proactive in seeking education on and a greater degree of association into the labor movement. While engineering education is well positioned to play a significant role in the reorientation of engineering away from its business professional history and toward power building through organized labor, leveraging that positioning towards such ends would require a foundational rupture of the linkage between the corporation and the university that established engineering education to begin with [2]. Rather than simply intellectualizing such a reorientation, engineering educators can lean into a praxis of labor education routinely performed by labor organizers that offers a power building basis for engineering education to draw from in rupturing that linkage [5]. If you are unsure of how to begin down such a path, the Emergency Workplace Organizing Committee (EWOC) is a good place to start [28].

Providing an initial encounter of electrical engineering students and unionized electricians, a unionized educator described how

> "we saw this [disconnect between higher ed and the practical world] when that group of engineers came down to our training facility for our electricians. It was interesting watching them go through and go up to a board, a circuit board and have all this knowledge of electricity, I mean they're electrical engineers, but they didn't know what, what to wire to where to where to where and it was interesting that our apprentices there went over and what they did is they timed them. And so … [the engineering students] were working it out and after 30 minutes [they could not complete the circuit]. An apprentice, a third year apprentice went up there and did it in 3 minutes. ... And it was humbling for those engineers to say 'we've got [a lot] to learn,' and so that's where this partnership with this [engineering research center] coming together with labor and the trades, this is what's going to make the difference. … we'll poke holes in everything and show them this might look good in a lab and where you're doing this out of your head or on paper and you're all think tanking this, but this is what you're gonna run into because they're not thinking about all the structure, everything [that has to go into place to make it work]." - *unionized educator*

Here this unionized educator described a scenario wherein engineering students can begin learning about labor unions from unionized workers in related fields. Regrettably, such was not the focus of this initial visit. Electrical engineering students visited a union training facility for electricians and experienced some limitations of the academic model of higher education and

greater emphasis of mental labor for engineers as compared to the apprenticeship model. While circuits are strongly associated with electrical engineering, this contingent of electrical engineering students that included graduate students were unable to complete a circuit problem that is more routinely experienced by the electricians. Humbling experiences such as these may help to shake the hierarchical status engineers have historically sought to hold above such workers [6]. While this educator highlighted different qualities of the education offered through the academy and the union apprenticeship, he described how they can be complimentary in ways they presently are not. Propagating more encounters between engineering students and unionized workers can offer key educational space for engineers to learn about labor unions and the labor movement. This can be especially beneficial in conditions where their engineering educators are themselves unfamiliar with or sitting outside of the labor movement.

Conclusion

Group interviews with unionized workers across a variety of industries offered insights into conditions at the intersections of engineering and labor. Two workers shared their pathways from engineering programs to labor unions. In both instances their prior knowledge of labor unions, rather than their education within the programs, influenced their decisions to join unionized worksites in 'blue collar' positions over non-unionized engineering positions. Unionized workers described an emphasis on safety in apprenticeship programs as well as how unions function as institutions that reduce premature death. Many workers discussed misinformation and disinformation propagated about labor unions that reflects a broader hostility to organized labor in the US. Workers also described negative impacts of engineers' interest in maintaining a hierarchical status above them, rendering their work more hazardous as they described ways engineers are also disconnected from on the ground conditions. Workers also offered suggestions of how union density amongst engineers could increase, with both existing labor unions and engineering workers taking proactive approaches to labor education that can include engineers visiting union training facilities.

Engineering educators can assist in turning engineers from business professionalism toward joining the labor movement and fighting for safer, healthier, and more just workplaces and worlds. Engineering education is positioned to bridge a critical gap around labor education that can bolster such a reorientation, however engineering education itself must be reoriented away from business professionalism to do so. Engineering educators openly embracing the calls from unionized workers to provide sufficient labor education for engineering students to proactively seek unionization upon entering the workforce is a necessary component of such a reorientation of engineering workforce development. The active participation of engineering educators in the labor movement by unionizing our own worksites, which are largely the academies that serve as critical junctures for the production of engineers, can provide a basis of knowledge both for ourselves and the students we are tasked with educating. Such education can take place both in the classroom and outside of it, especially in the context of Bargaining for the Common Good campaigns wherein workers organize alongside community partners to leverage their bargaining power towards exposing corporate actors driving precarity and towards conditions for healthier, safer, and more just communities to thrive in [5]; [29]. Learning lessons from and building

relationships with unionized workers and union organizers offers one means of transitioning away from the alienating culture toward the labor movement that continues to permeate engineering and engineering education today.

Acknowledgment

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