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Becoming after college: agency and structure in transitions to engineering work

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ABSTRACT

Engineering education and engineering studies research has clearly articulated a need for educational reform to help new engineers understand social dimensions of their work and act as change agents. At the same time, while some practicing engineers may be committed to systemic change and service to society, they must also contend with work responsibilities which serve corporate interests and constrain change. To highlight tensions between calls for socially just engineering education and the corporate contexts constraining engineering work, this study examines the transition to work for one early career engineer. Drawing on the concept of figured worlds, we examine the under-explored relationship between the agency of individual engineers and the structure of engineering workplace culture. This structure-agency approach guides our narrative analysis of the participant's early work experience based on five interviews across her first two years of work. Our findings illustrate the need to extend representations of both educational preparation and engineering work by unpacking the complex identity negotiations that individuals experience. In doing so, we also demonstrate the value of both the structure-agency framework and narrative methods for identity researchers in both engineering studies and engineering education.

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Introduction

Scholarly critiques of engineering education identify problems rooted in engineers' lack of social-cultural and ethical awareness and the absence of professional skills. In response, educators have proposed varying conceptions of holistic or heterogeneous engineering education to simultaneously improve both socio-political awareness and workplace preparedness so that new engineers can effectively practice socially-just engineering in their workplaces. But research in engineering studies complicates these holistic approaches on multiple fronts. First, research highlights the ways corporate (and other organizational) structures constrain engineers' agency.[1] Engineers are pushed to acquiesce to the demands of the community to which they belong; they cannot simply act according to an ideal, holistic or not. Second, translating skills between school and work is complicated by contextual

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differences. As Benjamin Lutz and Marie Paretti's study in this issue illustrates, professional skills learned in one context (e.g. school) cannot simply be transported to a new context (e.g. work) because they require nuanced adaptation to the specific people, norms, and cultures that engineers encounter.[2] Finally, if holistic engineering education focuses on preparing individuals to slot into an existing workforce, it may in fact inhibit their ability to define and address their own problems agentically and conscientiously and thus still fail to achieve change.

How are we to make sense of these discrepancies between idealized goals for engineering education and the realities of engineering work? In this study, we propose and illustrate an approach based on Holland et al.'s framework of agency and structure in figured worlds[3] to examine the ways in which new engineers negotiate engineering identities in local contexts. Through a narrative analysis of a single newly hired engineer, we illustrate the ways in which Holland et al.'s framework both names the tensions embedded in the transition from school to work and suggests potential directions for liberatory pedagogies. To that end, we ask, 'How does the agency of a new engineer interact with the structure of corporate work?'

Background

Critiques of engineering and engineering education

Given the apparent failures of engineering to provide just, equitable societal benefit, engineering studies and engineering education scholars offer multiple critiques. Ideologically, scholars highlight the ways engineers view their work as apolitical and fail to consider its social and cultural social impacts.[4] Such normative views of engineering posit a generalized 'society' that benefits from engineers' control of deterministic technological advancement.[5] These views are then reflected in curricula, where students are educated to devalue the work required for justice, to prize traditionally white and militaristic engineering knowledge, and to design for decontextualized 'basic human needs.'[6] Not surprisingly, then, in practice engineers struggle to distinguish social from corporate benefit.[7] More prosaically, critiques highlight a competency gap wherein school continuously fails to adequately prepare new engineers for work.[8] For over 100 years, reports and studies have cited new engineers' gaps in a rotating stream of practical and professional skills, business knowledge, critical thinking, and more. Current gap narratives, for example, stress differences between the well-structured, single-solution problems solved by individuals in school and the ill-structured, open-ended problems embedded in socio-technical complexities and addressed by teams typical of engineering work.[9]

Holistic engineering education as a solution

In light of these critiques, researchers and educators have turned to 'holistic' or 'heterogenous' educational approaches that range from the integration of social justice mindsets to the integration of key professional skills.[10] Ideologically, holistic approaches propose training students to acknowledge the social dimensions of their work, accept social responsibility, and work for social justice.[11] New activities, such as transformational listening, critical self-reflection, and political awareness may enter the engineering repertoire.[12] Practically, such approaches argue for greater inclusion of professional skills such as communication

and teamwork, business acumen and leadership, or creativity and innovation to better prepare students for work – and implicitly to better prepare them to solve complex global problems.[13] Collectively, these holistic approaches argue that engineering education must move beyond a narrow focus on fundamental engineering sciences and mathematics if the engineers they produce are to justly, equitably, and effectively solve global problems.

Counter-narratives of constrained agency

Holistic approaches to engineering education implicitly position new graduates as heroic change agents, taking new engineering identities into professional work to produce more social justice, or at least more effective problem solving. Yet research on engineering work challenges that premise in multiple ways. First, engineering studies scholars disrupt narratives that equate preparing students for corporate work with educating them for societal benefit. Any given technology may solve some social groups' problems while disadvantaging other (often less powerful) groups.[14] And engineers commonly seek to maximize efficiency or profits,[15] which may not benefit groups beyond a company and its stakeholders. Engineering is also deeply entangled with military dominance and colonization, and even apparently 'beneficial' work may be rooted in charity, 'help,' or control, rather than justice.[16] Better workers, that is, do not inherently secure justice.

Second, even when engineers are not only committed to, but knowledgeable about holistic engineering, research demonstrates limits on individual heroism. Historical studies show that while engineers may have once had autonomy in selecting and defining problems, they have increasingly lost technological leadership and now work primarily for corporate interests.[17] Contemporary case studies bear this out, illustrating the ways organizational hierarchies, entrenched practices, and corporate decision-making processes limit both what engineers can do and who they can be – even when they have been 'holistically' educated.[18]

Third, framing education as the solution to a gap between school and work perpetuates an oppressive 'human capital' model that treats school as a tool for preparing people to perform constrained societal functions that support existing institutions and status quos.[19] More than forty years ago, David Noble identified this pattern in engineering education in particular: '[E]ducation was [and is] the critical process through which the human parts of the industrial apparatus could be fashioned to specifications.'[20] Dewey, Freire, and the scholars who follow them pose alternative liberatory models of education that frame societal benefit as the result of developing reflective, self-determined, and collectively-active persons.[21] Freire, for example, roots societal change in students' ability to voice the problems of society as they see them, and fashion themselves to solve those problems.[22] His educational model centers on students' agency, promoting independent thinking and participation in an informed community as the basis for a liberated society.

Becoming engineers: structure and agency in the figured worlds of engineering work

Mindful of these counter-narratives, and particularly of critiques centered on treating students as objects to be 'fashioned to specifications,' we turn away from skills-based

approaches and instead consider the relationship between school and work from the perspective of identity. Our focus on identity is grounded in situated frameworks, in which learning – at school or at work – is not simply the acquisition of 'knowledge, skills, and abilities,' but a process of becoming in which individuals forge new identities as they engage in the practices of a given community.[23] Importantly, this identity development is not simply a one-way assimilation in which blank slates are imprinted with new identities wholesale; rather, it is an ongoing negotiation between individuals and the communities they enter. And it is in this negotiation, we argue, that both possibilities for and constraints on change emerge. To that end we seek to explore what the process of becoming an engineer at work might tell us about the role of engineering education as a site for transforming practice.

While researchers have explored identity development in undergraduate engineering programs, few studies have examined it in engineering workplaces.[24] Studies that do focus on professional practice often capture only single points in time,[25] though scholars such as Wendy Faulkner, Andreas Buch, and Lisa McNair and Marie Paretti have conducted longitudinal workplace ethnographies[26] and the Academic Pathways/Engineering Pathways Studies have traced the career paths of individuals from school through work over several years.[27] While such studies have made important contributions to our understandings of school and of work, we argue that more process-oriented research is needed to better understand how new graduates become practicing engineers – which in turn offers new avenues for interrogating the relationships between school and work.

To inform this exploration, we turn to Holland et al.'s concept of figured worlds, which frames identity as an ongoing improvization between individual agency and the structures individuals encounter.[28] This framework defines agency as the distinguishment of an individual's identities from their surroundings. Accordingly, all individuals have 'agency,' because no individual identifies (or thinks, or acts) exactly as prescribed by their social context. This agency depends not only on what individuals do, but also on whether they are driven by externally-prescribed identities or internally-negotiated ones. Holland et al. distinguish between the internal and external by drawing upon Bakhtin's descriptions of authoritative versus internally-persuasive discourse. In authoritative discourse (without agency), an external voice overwrites internal dialogues and then is reproduced by an individual, whereas internally-persuasive discourse encompasses agency as individuals develop their own voice through a sensemaking dialogue among multiple voices.[29] In the figured worlds framework, an individual's demonstration of agency does not require them to act against, or without regard for, the interests of their surrounding social context; instead an individual's agency is visible when they have the opportunity to question, make sense of, and (if they desire) challenge the identities prescribed for them.[30] Lastly, drawing on Inden, Holland et al. note that this agency is not only focused inward; it is also what allows individuals to 'remake the world in which they live, in circumstances where they may consider different courses of action possible and desirable.'[31]

This 'world in which they live' is what Holland et al. define as the figured worlds that provide the structures within and against which agency operates. These figured worlds represent landscapes of 'socially produced, culturally constructed activities' within which individuals continually negotiate their identities. Figured worlds have four key characteristics: 1) they are historical, with existing practices and patterns that new individuals enter

into; 2) they are organized around social positions that constrain what individuals can do and who they can interact with; 3) they are maintained through social organizations and connections; and 4) they distribute individuals across multiple typified social roles across the organizational landscape of action. Holland et al. explain how figured worlds are 'narrativized or dramatized' in that they form 'a "standard plot" against which narratives of unusual events are told.'[32]

Holland et al. then frame the interactions between structure and agency as identity improvization, explaining that 'the identities we gain within figured worlds are thus specifically historical developments, grown through continued participation in the positions defined by the social organization of those worlds' activities.'[33] In engineering terms, we might say that individuals 'MacGyver' their identities using the cultural resources at hand. These resources might include the local norms or attitudes, company mantras, and established practices that constitute the figured world of work, but they also include personal values and goals, prior learning, and reflective practices that individuals bring with them. These personal resources are central to individuals' exercise of agency within figured worlds. Framing identity development as improvization implies that the figured world of a given company cannot completely determine who an individual engineer becomes, because individuals bring resources from the outside world to the process. Holland et al.'s framework thus offers a lens for understanding engineering identity development through the interactions of structure and agency, which in turn provide opportunities for critiquing narratives of what engineering education can or should do.

This framework also resonates with the other studies in this special issue. The organizational learning identified in Lutz and Paretti's article, for example, relies heavily on the historical dimensions and social positioning of the figured worlds that new engineers enter.[34] Beddoes' work interrogates the ways in which gender and other typified identities intersect with and are constructed by the social organization of work. [35] And Jesiek et al.'s work provides new ways of understanding the landscapes of action that early career engineers move in and through as they engage in boundary work.[36]

Methods

To illustrate the value of Holland's framework as a lens for examining engineering work, we present a narrative analysis of one individual as she improvises her engineering identity across her first two years of work. Narrative analysis is useful in this context because it provides tools to explore 'the interactions among the developmental process of identity formation, the particular context in which identity develops, the identity choices the individual makes within that context, and the broad historical changes that provide a background for the process.'[37] It is thus well-suited to exploring the dynamic interplay between structure and agency foregrounded by Holland et al. Narrative analysis thus complements more traditional quantitative and qualitative approaches because it affords opportunities to trace the complex social and cultural dynamics that shape and are shaped by individuals over time. In doing so, it yields 'unique insights into the range of multiple, intersecting forces that order and illuminate relations between self and society.'[38] Because of its ability to capture the richness of individual experience, narrative analysis is also increasingly appearing in engineering education research to complement existing approaches to studying engineering identity.[39]

Selecting a single participant

Following education researchers such as Cynthia Foor, Susan Walden, and Deborah Trytten, and Delia Marshall and Jenni Case, we focus here on a single participant.[40] This choice enables us to provide a richly detailed exploration of both Holland et al.'s framework and narrative analysis as tools to critique idealized narratives of engineering preparation and holistic education. As Kellam et al. note, the constructed narratives that result from such analysis can exceed the length allotted to results in traditional journal articles, and the selection of one participant allows us to present her narrative in its entirety here – an ethical choice that itself aligns with our larger intention to move beyond treating emerging engineers as 'parts fashioned to specifications' and instead attend to them as individuals. In addition, the deep understanding of one participant helps prioritize her individual voice, rather than crowding her out with other voices and subsequently relying on potentially reductive categories to communicate the results of the analysis.[41]

Our participant was selected from the longitudinal multi-case Capstone to Work (C2W) project, which followed new graduates through their first year of work.[42] The C2W project recruited participants over two graduating years from four geographically diverse institutions. All four had industry-focused capstone design courses that simulated engineering workplaces. Data included a pre-graduation interview, weekly surveys during participants' first twelve weeks of work, and interviews at approximately three, six, and twelve months of work. In addition, female participants from the first study year were invited for a two-year interview. All interviews were audio-recorded. Details on the methodology are available in an online protocol document.[43]

In selecting the participant for this study, we used purposive sampling to identify a potentially paradigmatic case – that is, a case that illustrates the negotiations between structure and agency experienced by participants across the full project.[44] Of the 140 individuals who completed pre-graduation interviews, sixty-five completed the three subsequent interviews. This set included twenty-six women (thirty-nine men, zero transgender participants) and twenty-one non-white participants (forty-two white participants, two not answered) based on self-reported data. Ten of the women also completed two-year interviews. From the sixty-five complete data sets, we selected twelve cases for narrative analysis based on the quality of the interviews (sufficiently detailed to support narrative analysis) and maximum variation by site (three per institution), company size, and gender.[45] Of those twelve, we selected one, whom we call Catherine[46] for this article.

Catherine graduated from a small (roughly thirty students per graduating class) engineering science program at a private institution. Her employer was a large (greater than 1000 employees) consulting firm. She self-identified as female and White. Several factors support choosing her as an illustrative example. First, her story is similar to other participants' in that it reflects her individual goals, resources that shape her actions, and workplace structures that constrain her choices. Her experiences mirror those of the other eleven participants selected for similar analysis,[47] and her transition experience echoes those seen in previously published narratives from the larger data set as she transitions from school to work.[48] Second, when analyzed as part of the full C2W data set to explore the school-to-work transition, Catherine's data aligned with the overall study findings: that is, like all participants she experienced a similar set of challenges related to teamwork and communication, self-directed learning, and identity development, and transferred learning from

her capstone course to meet those challenges.[49] At the same time, her story is particularly relevant to narratives of holistic engineering education because she entered work with a strong commitment to sustainability, often a component of holistic approaches, and her experiences often related tothis issue.

Data collection

Catherine participated in all five interviews: an in-person interview prior to graduation, followed by interviews (conducted by Gewirtz) via phone and video-chat after four months, seven months, 13, and 25 months. The interviews provided richly detailed accounts that supported narrative analysis. Though focused on participants' transitions from school to work, the interview questions also addressed participants' responsibilities at work, their perceived preparedness for those responsibilities, work cultures, interactions with colleagues, and organizational values. The protocols varied slightly across the year, with opportunities to tailor questions based on the previous interview and questions at the one and two-year points that elicited broader reflections on participants' overall work environment.[50] Though the interviews were not designed for narrative methods, the semi-structured protocol and interviewing approach supported narrative analysis. Gewirtz rarely interrupted as participants shared work stories and described both events and their interpretations of those events.[51] Moreover, the protocol encouraged follow-up questions to explore these stories more deeply, and participants could direct the interview by sharing stories about topics they deemed relevant. Allowing participants to guide the interview improved the communicative validity of the data, and provided a liberatory quality by allowing participants to pursue topics that might not occur to a privileged interviewer.[52]

Data analysis

To analyze the data, we employed what Kellam et al. term 'thematic narrative analysis,' which focuses on 'identification of themes within a specific case,' often guided by prior theory, and 'keeps the narrative intact throughout the analysis.'[53] A similar method was employed by Jesiek et. al. in their article for this special issue.[54] Following professional transcription of the interviews, Gewirtz listened to the audio to correct inaccuracies, add behaviors or inflections (e.g. '[laughter]'), and attend to emotions communicated via tone, pauses, and other cues. This listening increased ethical validity and trustworthiness by attending to the emotions and social reality being shared.[55]

Using a two-step process,[56] we first used coarse coding to locate narrative incidents and segments about identity and relationships to work, particularly in terms of structure and agency.[57] Fine coding then determined how these narrative incidents and segments framed the structures of Catherine's organization; her relationship to these structures, including company philosophy, practices, and mission; her agency with and against these structures; and changes in her identity over time.[58] Memoing was used throughout to propose tentative explanations that might fit patterns in the data, to compare Catherine's narrative to those of other participants, and to preserve incongruent or unexpected elements to enable ongoing revision of the interpretation.[59] This process improved ethical validation and trustworthiness by lessening the effect of preconceptions and stereotypes.

Finally, the codes were used to construct the narrative, focusing on the interaction of structure and agency as Catherine negotiated her engineering identity and integrating her language where possible to capture key points.[60] This approach enabled us to increase the impact of the narrative in a more compressed space, while still preserving the layers of her story.

Limitations

Our findings are qualified by several limitations. First, as noted, Catherine is paradigmatic but not uniformly representative. That is, she reflects the ways in which other participants improvised their professional identities in the context of their engineering figured world, but the nature of those figured worlds, as well as newcomers' responses to them, necessarily varied by individual and context. Moreover, because participants in the C2W study constituted a self-selected sample from four institutions, the findings cannot be generalized to all U.S. engineering graduates. Second, narrative construction can blur distinctions between researcher and participant; however, the narrative remains grounded in sustained analysis of the empirical interviews, and the constructed narrative intentionally includes phrases drawn directly from the interviews. Third, we did not solicit member checks for the constructed narratives. However, participants did provide feedback on both the overall study and researchers' conceptions of their work throughout the interviews by answering clarifying questions and reacting to prior study results. Finally, the interviews did not explore personal identity dimensions such as race, religion, sexual orientation, or socio-economic class unless participants chose to reveal them.

Catherine's narrative

At her first interview, Catherine had accepted a job working for a multi-national consulting firm specializing in large infrastructure building projects (e.g. shopping malls, airports, convention centers, transportation centers). As Catherine prepared for this work, she described multiple characteristics that, in Holland's terms, formed the personal resources she would later draw on to exert agency within the figured world of work. In her interdisciplinary capstone project, what set her apart from her architecture teammates was her ability to 'go for it, [to] figure out the process for yourself [rather than] waiting for set instructions.' This sense of drive was evident in her current activities: her new job was going to involve CAD work, and while her capstone project provided some preparation, she also prepared herself with online tutorials for the program used at her new company before starting work.

Catherine also identified personal values that shaped her expectations for work. She had 'always wanted to go into renewable energy,' and her new employer's commitments to sustainability was part of what 'sold' her on the job. She also noted that her only prior work experiences were five years spent working with children, and it was 'going to be strange being in the professional workplace. … [She didn't] want to lose the sense of childness.' She was nervous, but she was also excited to learn that the employees of the company were 'like family,' doing lots of activities like group hikes and sports together outside of work.

During the first four months, several features of the figured world of work emerged. First, routine CAD work structured much of Catherine's time and reflected historically established practices she was expected to adopt. She spent much of her days either doing CAD or

attending trainings paid for by her company; when she had spare time, she signed up for company-provided online videos and tutorials for CAD, load calculations, and other skills of value to the company. Some of the CAD work 'seemed mindless' to her, though there was some decision-making involved in positioning parts. At the same time, as she engaged with historically established work practices, her potential for agency emerged as she described wanting to be an *important asset* to her company, 'instead of just being someone who could do anything that [was] asked of [her].' One way to do that, she believed, was to become a go-to person, and 'set [herself] apart' by learning how to do energy modeling.

Second, Catherine was socially positioned as a newcomer at work. The primary expectation of the role, gleaned from her co-workers, was that she 'absorb as much as [she could]. They didn't expect [her] to be a professional right off the bat.' Beyond time spent in training, her work followed a larger company-specific process that involved multiple stakeholders – city governance, customers, suppliers – but she found it 'hard to understand what [her] next steps should be.' She was interested in 'exceeding their expectations of [her] as much as [she could],' but even 'if [she] had ideas of what would help,' it was hard to know what to do given her newcomer position.

Finally, she appreciated the ways the flat social organization made the company 'feel like family.' As expected, there were sports events employees participated in. They had a wellness room where employees could take naps if needed. She felt that the company did not just 'talk a big game; they actually cared about her wellness.' The company was flexible, too, about how people worked. If someone had a family or, in one case, a second job, they could adjust their hours by request. In her case, she was able to leave work early to attend a political rally. The company appeared to have 'a good focus on work-life balance.'

After seven months, Catherine had begun to assume a typified role identity as a company asset, though not entirely in the terms she had hoped for; historically-situated corporate priorities continued to structure her work. She had become one of the regulars doing CAD for skyscraper[61] projects – the type of projects assigned to her that formed a key part of the company's work. She was able to use her 'best judgement' to decide where certain parts should go, and she did 'feel like [her] opinion [was] being taken seriously, which [was] something [she had been] hoping for.' But laying out parts was not her primary interest; she still wanted to do energy modeling.

At the same time, she had 'an empowering experience' doing a small renewable energy project she learned about through a company-related mentorship group. After a conversation with one of her mentors about her career plans, she was given the chance to spend a week designing green energy systems for a few buildings. Beyond that project, her plans were to 'carve out a career path for [herself] and [bridge] the gaps between disciplines at the company – getting groups to work together in ways not currently part of the organizational landscape of action. Practically, this meant 'studying all the time' and continuing to pursue sustainable work opportunities. Energy modeling was a task that most team members had only done once or twice, so she saw it as a chance to be an 'asset' while also meeting her own goals. The opportunities for energy modeling were 'slow moving,' but she was in a 'queue' to work on one. In the meantime, she looked for sustainability work opportunities through the 'mentorship circle.' Thus, within the boundaries set by the company's historical practices, she still felt she would be able to improvise an identity that would make her an *asset* while simultaneously prioritizing her interest in sustainability, but this process would involve looking for new work through other channels.

In between four and seven months at work, Catherine had also 'started to struggle with work/life balance.' From school she was 'used to working on things until they were perfect,' but it wasn't 'reasonable' to be doing that in a company in which the social organization was structured such that every problem had a 'back and forth' with different groups and departments. A supervisor assured her that 'as long as [she was] doing her work and doing it efficiently,' she could go home after eight hours.

At one year, Catherine was still working on skyscrapers, a position that reflected the landscapes of practice within the organization and the ways in which individuals came to occupy typified roles. She had some design flexibility – selecting from a catalog of parts and decisions – and she did negotiate problems with the architects – but she felt a little 'annoyed,' a bit 'skyscrapered out.' After hearing a co-worker talk about how he unwittingly became 'the skyscraper guy' she thought 'Oh my god, I don't want that to be me.' She wanted 'to learn how other buildings operate.' She had to remind herself that '[she had] plenty of years ahead of [her] to work on other things.'

Despite the prescribed skyscraper work, she also continued to exert agency to negotiate an identity anchored in sustainability. For example, she briefly took over a green energy project, learning to use spreadsheets in new ways and meeting with clients for the first time since starting work. However, because the team used a traditional (for the field and for the company) 'method for financial calculations,' the project 'went with recommending [combined heat and power], which was not really green, over their green option.' After she submitted the report, her mentor showed her an alternative calculation method that would have positioned the green system more favorably. 'Even though [they] didn't have a huge success in that project, [she felt] good about it' because it was the kind of work that she wanted to do, 'the reason why [she] went to engineering in the first place.'

Her efforts to negotiate this identity were constrained by the figured world in other ways as well. While the managers of the two projects (skyscrapers and green energy) were open to Catherine's splitting her time, the skyscraper project manager was skeptical regarding whether she 'had the time' to work on both, reflecting her social position in the hierarchy as well as the historical practices structuring work. To maintain her position, she needed to 'stand up for [herself]. 'I definitely do have time and this is actually what I want to be doing … I know you don't want me to work on this project, but I'm going to because it is my decision and I will still get the skyscraper work done.'' When she demonstrated to the skyscraper manager that she could accomplish the tasks for both projects on time and effectively, his skepticism faded. By standing up for herself and demonstrating her efficiency, she successfully claimed a unique identity, positioned in between two ongoing kinds of work.

At the same time, tensions around work/life balance persisted as she learned more about implicit organizational expectations and historical practices that differed from the espoused commitments to work/life balance. Overtime was not required, but as she gained more responsibility, she recognized that 'people [would] expect it from [her] if there was a deadline coming.' She noticed that some co-workers without families ate lunch at their desks and stayed until 10 pm rather than attending company sports games. There was a 'devotion to finishing a project' on time that she sought to emulate. Working late made her feel 'needed and valued.' She liked being able to say 'Sorry, got ordered late today. I need to finish this deadline.' And if she needed to stay late for overtime, the company 'made it easy' for her by reimbursing her for a taxi home. Yet she still felt that 'no one expect[ed] work to be [her] highest priority if [she had] something to do after work and [she needed] to leave.'

As she explained, 'there are times when I think 'I f***ing love this place.' There are times where I think, 'I'm getting a little bored of doing the same kind of work.' But I feel that's to be expected out of almost any job.' She admitted, though, that she was only a year in, so didn't 'have much power to change things.' In general, she felt 'very lucky to be where [she was],' and intended on staying with the company.

Throughout her first year, Catherine leveraged personal resources emergent in her post-graduation interview to construct her engineering identity: drive, commitment to sustainability, desire to be a needed 'asset,' ability to work across boundaries. But the year was also marked by structural constraints: assigned work disconnected from her interests that dominated her time, lack of support for sustainable financial practices, the need for a mentorship group to find sustainability work, and widely-held expectations about working long hours.

After two years, these tensions between work she wanted and work as it was structured came to a head. She had been 'trying to balance being the leader of a local climate activist organization,' and work. Now the landscape of practices at work felt different. 'There's all these things [she] could be doing that [she] also love[s], that are also benefiting the world. Then there's other actual work you have to do.' She found herself doing activist work during the workday and bringing engineering work home after hours.

Constructing her work identity around sustainability required ongoing negotiations between structure and agency. Although she was finally becoming one of the few people in the office who did energy modeling, the externally-imposed format and schedule for the results was not aligned with the actual work. She found it 'frustrating' to be given 'deadlines and expectations as a junior engineer when the person above [her], who [was] giving them to [her], [didn't] know how to use it and [didn't] know how long it [took].'

She had also recently been assigned to projects requiring 80-hour work weeks – primarily because of her social positioning, which had shifted from newcomer to junior engineer. She noted that the company generally assigned junior engineers to these intensive projects because it was a 'good learning process' that let them go 'through beginning to end' of design quickly. Because she was so busy, 'a lot of her friendships [had] become tenuous.' She framed this tension in terms of her own agency, though, admitting that '[she was] choosing to do this' – i.e. work so much. Next year, in a different position, '[she would] have more time.' But her agency was constrained by assigned deadlines and historical practices that positioned such choices as common. Perhaps most notably, she found that she was 'scared to work part-time.' The coworker with two jobs mentioned in her four-month interview had been laid off, along with several others, 'after the company lost a big project and a lot of money. [It was] not because of the part-time, [or maybe it was] because he worked part-time. [It was] random, unexpected, [and the company] did not communicate to anybody.' Her positioning, which left her with little information, created uncertainty about whether she could work part-time. She erred on the side of working harder because her position meant she feared being laid-off otherwise.

Her understanding of the larger social organization of work had also changed. In place of the family atmosphere, she found herself in petty competition with a coworker, which had been 'making work suck.' Her co-worker sat next to the lead mechanical engineer; those two talked often, and lately she'd been left out of conversations and emails. She also experienced conflict with a senior engineer who had assigned her work without communicating his expectations. When she fell short, he 'got mad,' talked with her supervisor, 'and sent [her]

a lot of rude emails.' He made her feel 'stupid.' In reaction to that imposed identity, she drew on her own resources. Because she knew she was good at confrontation, she spoke with him directly about the miscommunication, which seemed to resolve the issue. Afterwards, she spoke with a co-worker who was also struggling with lack of communication. 'Okay, I'm not crazy,' she thought. 'There are people who, for some reason, don't think that communication is important.' But she also knew that other figured worlds were different. For example, in her activism, 'everything [they did] was about supporting people, making sure people feel uplifted with their work,' but in engineering, 'it [was] all about getting work done on time.'

Another shift was the dissolution of the mentorship group she had joined in her first year. It was only a 'temporary thing,' meant to 'happen for six months' or so. She 'mentioned it to [her] supervisor as something they should try again.' Her supervisor reminded her that 'anybody can be your mentor' and she did not 'have to do it in such a structured way.' She realized that 'maybe [she] should spend more time connecting with people in the office.'

Catherine's self-assessment was also shifting. Having just had her two-year review and having assessed her own progress, Catherine wondered whether she was a 'slow worker.' She felt that 'every time [she took her] time to and do [her] work well, [she's] taking almost double the time of what [was] expected, and budgeted. [She] found [herself] trying to do things fast at the expense of her work.' She was now trying to eliminate distractions. She never considered herself distracted by her phone, but she did listen to podcasts while working. Since eliminating those, she was 'able to 100% focus,' and started getting involved in conversations about technical topics she was still learning, which 'pulled [her] into the work a lot more.'

After two years, Catherine no longer felt able to easily maintain simultaneous identities as a company asset and as a sustainability engineer. The work she loved and the work she had to do were separate. Her channels for finding sustainability work within the company had dissolved, along with other dimensions of the figured world she had appreciated, such as a family atmosphere and the opportunity for part-time work. Though she had finally started doing energy modeling, it wasn't established enough for her managers to have experience with it or to have reasonable (or at least well-communicated) expectations of her work. While she still maintained sustainability-focused work through her activism, the figured world of work now seemed focused on deadlines and budgeting. She had come to adopt the identity of 'slow worker,' and she saw this as something she had to disprove by knuckling down and maintaining a 100% focus on her assigned work to better fit into the typified roles expected of her.

Discussion: becoming an engineer in a figured world

We framed this study by asking how the agency of new engineers interacted with the structure of corporate work, guided by Holland's concept of identity as an improvizational negotiation in figured worlds. As the narrative shows, the figured world that Catherine entered included historical practices associated with CAD and energy modeling; supervisory structures where Catherine had little input into or control over her assigned tasks and deadlines; patterns of social interaction that included both an overt 'family atmosphere' and implicit expectations about long hours, along with interpersonal conflicts and communication gaps that 'made work suck'; established priorities around profit and efficiency;

and landscapes in which individuals are slotted into particular roles like 'the skyscraper guy' and only certain types of work are deemed central to the company's core mission. Into this world, Catherine brought her commitment to sustainability that guided her into an engineering career, her self-concept as someone who can take initiative and figure things out on her own, and her need for work/life balance and time for activism outside work, along with her clear desire to 'set herself apart' and be an 'asset' to her company.

In becoming a practicing engineer, Catherine continuously leveraged resources within and beyond her organization to construct engineering identities that both she and her supervisors could consider competent.[62] She looked to a mentorship group for opportunities to engage in sustainability practices, and at one point asserted the validity of her sustainability project work by arguing that it would not detract from her assigned CAD tasks. At two years, she drew on her activism experiences to practice communication which she considered proper and valuable. But she also experienced contradictions and dissonance created by the figured world. Although Catherine chose a job that 'sold' itself to her with espoused commitments to sustainability, work/life balance, and a flat-structured family atmosphere, over time those selling points seemed less accessible, and work provided an increasingly constrained pool of identity resources. Working part-time became less viable; opportunities for green energy work were infrequent; and effective interpersonal communication was not universally valued or practiced.

The narrative thus illustrates the ways in which Catherine exercises agency to negotiate – sometimes successfully and sometimes not – with the figured world to construct her engineering identity. She engaged in green energy efforts after justifying them to her supervisors, and she learned new skills to support future green energy projects. She solved logistical issues by employing her activism skills in communicating with her supervisor. Her holistic efforts were validated through her mentorship group, where she acted on her commitments to sustainability, and through conversations with colleagues that affirmed her decision to prioritize careful communication over tight deadlines. Yet her work was still constrained: green energy tasks were not central to her job and she needed to put in the long hours required by assigned tasks and deadlines. The narrative illustrates the ways in which Catherine neither wholly accepted and internalized the structures of work, nor wholly resisted them; rather she dialogically tested, rejected, adapted to, and tolerated them. Perhaps fittingly, our data from Catherine ends with an ambiguous understanding of Catherine's perception of herself as a 'slow worker' and her intention to refocus her time and energy to change that characterization. Her questioning of whether that identity applies to herself reflects an internal voice in dialogue with an authoritative discourse of work at an acceptable speed – a dialogue which was not resolved at the time of the interview.

This process of becoming – as illustrated by Catherine's narrative – resonates with the other qualitative explorations of early career engineers in this issue. Her experiences echo with the social and cultural learning described by Lutz and Paretti as she learns both the espoused values of her company and the actual ways of working, navigates relationships with supervisors and coworkers, and negotiates the politics of power as she pursues energy modeling.[63] Her energy modeling work also embodies the boundary spanning practices examined by Jesiek et al.; Catherine has to work across traditional and emerging practices as she negotiates time and effort with multiple supervisors. Communication, knowledge management, and coordination are evident in her practice, as are boundary crossings within and across teams and around her own expertise.[64] Moreover, while Catherine did not identify

gender as a salient factor, the vignettes described by Beddoes inevitably raise questions about ways gender may have influenced the perceptions of Catherine's supervisors, the communication challenges with her colleague, and even her self-characterization as 'a slow worker.' As noted in a previous narrative analysis of four women from the C2W project, gender is 'not a homogenizing force,'[65] but it does continue to manifest in the ways women experience engineering workplaces and cannot be discounted here.

Our findings also echo ethnographic studies that illuminate the ways workplaces practices constrain who engineers can be. Like the engineers in Buch's study, Catherine finds it challenging to enact holistic engineering practices within a larger landscape of workplace practices.[66] Her energy modeling, like the holistic work of the team Buch followed, was constrained by entrenched corporate methods and values. Similarly, like the engineers in McNair and Paretti's work, her identity was continually circumscribed by the roles into which others placed her – as newcomer, as skyscraper person, as junior engineer.[67]

At the same time, by examining one new engineers' experience in depth through a narrative of structure and agency, we extend this prior work by treating identity development as an improvizational process that engages both the constraints of a given figured world and the personal resources and experiences individuals bring to those worlds. Like Holland et al., we seek to '[pay] more attention to the improvisation itself, to what was produced [and] try to see both culture and subject position at the same time.'[68] This negotiation between structure and agency calls into question a simplified educational approach to engineering holism. Catherine could not simply transport either her skills or her personal values directly into her new workplace unaltered; becoming an engineer is something more complex. Her choices mattered, and she leveraged prior learning, but she also continually learned new skills and adapted old ones as she worked to prove herself useful in terms of existing corporate values and contended with an existing array of corporate structures. Rather than treating students as unrestricted change agents, then, narrative accounts of individuals that acknowledge both structure and agency help to distribute responsibility for socio-technical change more appropriately between individuals, who may or may not be committed to acting holistically, and corporations, which may provide or constrain opportunities for holistic engineering. This dynamic in turn asks educators to consider whether curricular reform should include discussions of how organizational structures constrain agency and how agency can be amplified in spite of those constraints.

At the same time, given the liberatory counter-narratives of education offered by Noble, Dewey, Friere, and others, educational reformers should be wary of reproducing pedagogies of oppression that reduce the purpose of education to uncritical preparation for existing activities and institutions. To that end, critical pedagogy and critiques of neoliberalism offer relevant cautions. Neoliberalism, in this case, refers to the transformation of higher education from an institution interested in defending and providing public goods into a profit-interested business that treats students as both customers and products.[69] The pedagogies of oppression that persist in neoliberalism limit students' abilities to imagine their own resistance (and thereby influences their agency).[70] Passion, commitment, working long hours, and other choices of working adults might be framed (by education or work) as vital or noble, but a tenacious commitment to work may also reflect complicity in exploitation, allowing corporations to extract more labor for less compensation without protest.[71] Instead of placing the blame for a lack of holism in engineering on individual students, critiques of neoliberalism remind us that distributing social responsibility solely onto

individuals is a common tactic for institutions to preserve their own power, while avoiding the question of their own responsibility.[72] Could Catherine's choices be explained by an education which prepared her to support corporate efforts rather than changing them (or abstaining, or other more imaginative options)? Could the structures of Catherine's work be explained by profit motive, rather than commitment to sustainability? Given the limitations of a single narrative, such questions and possibilities remain tentative in this study, but extended work on a larger set of narratives from this study have indeed offered fertile ground for re-imagining the liberatory potential of education to help students more clearly see the choices, limitations, and possibilities of their own careers.[73] Perhaps most importantly, even a single narrative helps us remember that we are not fashioning tools but rather educating individuals. And just as Catherine's process of becoming at work was not the assimilation of a prescribed corporate identity, students in our classrooms are not simply adopting the identities – engineering or otherwise – that we choose for them.

Conclusions and implications

As we explained earlier, our goal in this paper was to use deep exploration of a single narrative to illustrate the theoretical potential of structure and agency and the methodological potential of narrative analysis to re-examine and critique narratives in engineering education, especially regarding prevalent assumptions about holism, engineers' agency, and company structures. Our example accounts for a complex negotiation between structure and agency, which in Catherine's case balanced working for sustainability, being an activist, maintaining a work-life balance, and being an asset to her company. Still, narrative ambiguity remains regarding what is and is not her choice. Was the company eager to assign 80-hour work weeks to new engineers, or was she choosing to sacrifice work-life balance? Did Catherine have an option to satisfactorily enact her commitment to sustainability through the company (e.g. through energy modeling), or did activism need to cut into work time for her to enact those commitments? Was Catherine a 'slow worker' or was she unusually diligent? Any narrative intended to critically represent a person's experience has a degree of open-endedness that cannot be resolved[74] and that limits our ability to draw unambiguous conclusions.

However, the theoretical and methodological approaches of this study still suggest possibilities for new critiques and new directions for educational reform, especially because they account for agency. For instance, our approach allowed us to focus on the 'whole' engineer and illuminate commitments that Catherine held beyond work such as those to her friends, to practicing sustainability, or to doing what she loved. Understanding these personal commitments counterchecks 'human-capital' models of education.[75] Personal commitments point instead toward the potential for liberatory pedagogies that allow students to define problems in terms of personal relevance, pedagogies that enable them to challenge the situations that confront them throughout life. Representing individual experiences in this way can humanize both our research and its impacts.

Moreover, the structure and agency framework, particularly when coupled with critical pedagogy and critiques of neoliberalism can illuminate larger systemic processes at play. Further work in this vein, for example, may suggest that education is a necessary but insufficient part of reforming engineering practice.[76] Other routes for reform, such as policy change,[77] or the enactment of STS Making and Doing as other scholars have suggested,[78]

may prove more consonant with students' structure and agency negotiations at work. At a minimum, our narrative analysis invites critique and reform efforts directed at the corporate structures that newcomers navigate. And through agency-focused narrative research, we ultimately attempt to avoid reductionism and err towards more faithful depictions of engineers' experiences that can challenge stereotypes and grand narratives.

Notes

1. e.g., Paretti and McNair, "Analyzing Identities in Engineering Work"; and Buch, "Ideas of Holistic Engineering."
2. Lutz and Paretti, "Exploring Social and Cultural Dimensions."
3. Holland et al., *Identity and Agency in Cultural Worlds*.
4. Faulkner, "Dualisms, Hierarchies and Gender in Engineering"; Lagesen and Sorensen, "Walking the Line?"; Cech, "The (Mis)Framing of Social Justice".
5. Smith, "Technological Determinism in American Culture," 1–17.
6. Leydens and Lucena, "Social Justice is Often Invisible," 5–19; Wilson-Lopez et al, "Latina/o Funds of Knowledge," 278–302; Nieusma and Riley, "Designs on Development," 55–8; Downey, "Normative Contents of Engineering."
7. Trevelyan and Williams. "Value Creation in the Engineering Enterprise."
8. Such critiques date back to the 1918 Mann Report and continue up through ASME's Vision 2030 and beyond.
9. Jonassen, "Engineers as Problem Solvers"; Bucciarelli, "Design Knowing and Learning"; Stevens, Johri and O'Connor, "Professional Engineering Work"; Trevelyan, "Reconstructing Engineering from Practice"; Anderson et al., "Understanding Engineering Work and Identity."
10. We use the term 'holistic' for simplicity to capture this spectrum.
11. e.g, Stevens, Johri and O'Connor, "Professional Engineering Work"; Cech, "The (Mis)Framing of Social Justice"; Duderstadt, "Engineering for a Changing World," 17–35; Cech, "The (Mis)Framing of Social Justice."
12. Riley, *Social Justice and Engineering*, 116–20; and Walther, Miller, and Sochacka, "A Model of Empathy," 133–41; Walther, Miller, and Sochacka, "A Model of Empathy," 128–33; Leydens and Lucena, "Social Justice is Often Invisible," 49–58.
13. National Academy of Engineering, *Educating the Engineer of 2020*, 53–7; Flumerfelt et al., *Lean Engineering Education*, 31–57.
14. Pinch and Bijker, "The Social Construction of Facts and Artifacts," 30–47; and Lucena, Schneider, and Leydens, *Engineering and Sustainable Community Development*, 103–11.
15. Date and Chandrasekharan, "Beyond Efficiency: Engineering for Sustainability," 12–37.
16. Riley, *Social Justice and Engineering*, 62–71; Riley, "Ends, Means, Ethics Grand(iose) Challenges," 1–11; and Lucena, Schneider, and Leydens, *Engineering and Sustainable Community Development*, 36–43.
17. Noble, *America by Design,* 46–7; and Wisnioski, "Servants of The System," 26–46.
18. Paretti and McNair, "Analyzing Identities in Engineering Work," 55–78; Buch, "Ideas of Holistic Engineering," 146–60.
19. Spring. *American Education,* 5–25.
20. Noble, *America by Design,* 168.
21. Kitcher, "Education, Democracy, and Capitalism," 359–79; and Freire, *Pedagogy of the Oppressed*, 99–108.
22. Freire, *Pedagogy of the Oppressed*, 85–6.
23. Johri & Olds, "Situative Frameworks"; Wenger, *Communities of Practice*.
24. e.g. Groen and McNair, "Developing a Grounded Theory"; Secules, et al., "Supporting Narrative Agency of Students".
25. e.g. Anderson et al., "Understanding Engineering Work and Identity"; and Hatmaker, "Professional Identity Construction".

26. Faulkner, "Dualisms, Hierarchies and Gender in Engineering"; Buch, "Ideas of Holistic Engineering"; Paretti and McNair, "Analyzing Identities in Engineering Work".
27. e.g. Winters and Matusovich, "Goals and Actions of Early Graduates"; and Brunhaver et al., "Understanding Engineering Students' Pathways".
28. Holland et al., *Identity and Agency in Cultural Worlds*, 1998.
29. Holland et al., *Identity and Agency in Cultural Worlds*, 169–84.
30. Matusov and Duyke, "Internally Persuasive Discourse in Education," 1–10.
31. Holland et al., *Identity and Agency in Cultural Worlds*, 42.
32. Holland et al., *Identity and Agency in Cultural Worlds*, 53.
33. Holland et al., *Identity and Agency in Cultural Worlds*, 41.
34. Lutz and Paretti, "Exploring the Social and Cultural Dimensions."
35. Beddoes' "Examining Privilege in Engineering."
36. Jesiek et al., "Performing at the Boundaries."
37. Phinney, "Identity Formation Across Cultures," 28.
38. Daiute and Lightfoot, "Theory and Craft in Narrative Inquiry," 4.
39. Kellam, Gerow, and Walther, "Narrative Analysis in Engineering Education Research," 1–11.
40. Foor, Walden and Trytten, "I Wish I Belonged"; Marshall and Case, "Rethinking 'Disadvantage' in Higher Education."
41. Lyons and Labosky, "Why Narrative Inquiry or Exemplars," 11–14; Slaton and Pawley, "Power and Politics."
42. Ford, et al., "Transitioning from Capstone Design Courses," 1–7.
43. Paretti et al., "Research Methods for C2W".
44. Marshall and Case, "Rethinking 'Disadvantage' in Higher Education."
45. For details on selection process and larger narrative project, see Gewirtz, "Twelve Tales of Engineering."
46. We adopt a pseudonym cautiously because pseudonyms can invoke race, class, and other demographic markers; however, for readability, we choose to refer to the participant by name in this article.
47. Gewirtz, "Twelve Tales of Engineering."
48. Howe et al., "Women's Transition to Engineering."
49. Ford et al., "Transitioning from Capstone to Workplaces"; Paretti et al., "Leveraging capstone design experiences."
50. For full details on interview protocols, see Paretti et al., "Research Methods for C2W."
51. Elliott, "Listening to People's Stories," 1–40; Riessman, "Narrative Analysis," 21–31.
52. Walther, Sochacka, and Kellam, "Quality in Engineering Education Research," 11–30; Secules et al., "Supporting Narrative Agency of Students," 4–11.
53. Kellam, Gerow, and Walther, "Narrative Analysis in Engineering Education Research," 2015, pp. 1–11.
54. Jesiek, Buswell and Nittala, "Performing at the Boundaries."
55. Sochacka, Walther, and Pawley, "Ethical Validation," 371–6.
56. Kellam, Gerow, and Walther, "Narrative Analysis in Engineering Education Research," 1–11.
57. Walther, Sochacka, and Kellam, "Quality in Engineering Education Research," 11–30.
58. Saldaña, *Longitudinal Qualitative Research*, 157–71.
59. Lempert, "Asking Questions of the Data," 247–58.
60. Kellam, Gerow and Walther, "Narrative Analysis in Engineering Education Research," 1–11.
61. Fictionalized to maintain participant anonymity; Catherine did become the go-to person for one specific type of building project, but not skyscrapers per se.
62. In the 6- and 12-month interviews, participants were asked about the results of any performance reviews. While those results are self-reported, the rapport between interview and participant, evident in the ways participants routinely talked about challenges, failures, and insecurities, suggest that the self-reports accurately capture participants' perceptions of those reviews.
63. Lutz and Paretti, "Exploring Social and Cultural Dimensions."
64. Jesiek, Buswell and Nittala, "Performing at the Boundaries."
65. Howe et al., "Women's Transition to Engineering," 20.

66. Buch, "Ideas of Holistic Engineering."
67. Paretti and McNair, "Analyzing Identities in Engineering Work."
68. Holland et al., *Identity and Agency in Cultural Worlds*, 16–17.
69. Giroux, "Neoliberalism's War on Higher Education."
70. Friere, *Pedagogy of the Oppressed*, 72–86.
71. Jaffe, *Work Won't Love You Back*.
72. Eagleton-Pierce, "Responsibility," 160.
73. Gewirtz, *Twelve Tales*.
74. Barone, "Case of Critical Storytelling," 1–5.
75. Friere, *Pedagogy of the Oppressed*, 72–86.
76. Case, "Educational Reform and Social Change," 1–11.
77. Jasanoff, "Technologies of Humility."
78. York, "Experiments in Critical Participation," 76–82.

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