

AC 2007-2414: ENGINEERING AS LIFESTYLE AND A MERITOCRACY OF DIFFICULTY: TWO PERVASIVE BELIEFS AMONG ENGINEERING STUDENTS AND THEIR POSSIBLE EFFECTS

Reed Stevens, University of Washington

Reed Stevens is an Associate Professor in the College of Education at the University of Washington. He specializes in ethnographic and comparative approaches to studying how people learn in STEM related fields. His research spans studies of informal and formal learning environments and is focussed on the link between the two. He is currently co-leading two NSF Centers working on issues related to how people learn, the LIFE Center and CAEE.

Daniel Amos, University of Washington

Daniel Amos was one of the first ethnographers from the United States to do ethnographic research in the People's Republic of China. He has taught at five Chinese universities, and directed the Chinese Studies program at Clark Atlanta University. His graduate degrees are from UCLA (Anthropology, 1983) and the University of Chicago (Social Science-Psychology, 1974). He is currently an Acting Instructor in the Department of Educational Psychology at the University of Washington.

Andrew Jocuns, University of Washington

Andrew Jocuns holds a PhD in Linguistics from Georgetown University. His research interests include: classroom discourse and interaction; narrative analysis; mediated discourse; and pragmatics. He is currently a Postdoctoral Research Associate in Educational Psychology at the University of Washington.

Lari Garrison, University of Washington

Lari Garrison is a Ph.D. candidate in Cognitive Studies in Education at the University of Washington. Currently, she works as a Research Assistant for CAEE (Center for the Advancement of Engineering Education). She received a B.A. and a M.Ed. from the University of Illinois at Urbana-Champaign and taught high school mathematics for ten years before beginning work on her Ph.D. at UW.

Engineering as Lifestyle and a Meritocracy of Difficulty: Two pervasive beliefs among engineering students and their possible effects

In this paper we discuss a series of narratives collected from ethnographic interviews with engineering students concerning questions about what they wish to be an engineer. Our paper reports on two related beliefs that we have found among engineering undergraduates, most commonly in their first two years of four-year programs. These are: engineering as a lifestyle and a meritocracy of difficulty. Engineering as a lifestyle refers to the anticipated comfortable life that students expect from their careers as engineers. In terms of a meritocracy of difficulty we are referring to how students' justify their anticipated comfortable futures based on the fact that they perceive their school work to be much more difficult than that of students in other departments. The reason that the difficulties of their engineering studies will merit them the comfortable material existence that comes from earning an engineering degree. This paper's analysis is based on data from a comparative, four-year longitudinal study of undergraduate students' pathways through engineering degree programs at four engineering schools across the United States. Our analysis of engineering as a lifestyle focuses upon how little first and second year students know about the actual practices of engineers. In a similar vein, a meritocracy of difficulty also persists due to this lack of understanding, as such we argue that students construct reasons for their expected future prosperity that if they work harder now, they deserve more later.

Introduction

It seems a universal feature of human experience to tell stories about one's place and direction in the world. Research on storytelling has shown that this is as true of individuals as it is of nation states.¹ Given this range, we can assume that members of cultural groups of sizes between individuals and nations will share common, if never identical, narratives. In this paper, we report on a collection of common narratives that come from a distinctive student culture, that of undergraduate engineering education in America.

Our paper reports on two related beliefs that we have found among engineering undergraduates, most commonly in their first two years of four-year programs. This paper's analysis is based on data from a comparative, four-year longitudinal study of undergraduate students' pathways through engineering degree programs at four engineering schools across the United States. The transcript data we analyze for this paper is derived from ethnographic interviews collected with students in each of the four programs over their first three years.

The first belief we call the *engineering as lifestyle* perspective. We find that when students give reasons for why they want to be an engineer, the most pervasive reason is to have a comfortable material existence. Students express interest in making a good salary, having the security of a professional position, and even the expectation of travel. Much less frequently, students speak for their goals of being an engineer in terms of the craft of engineering or the actual impact of engineering work on society. Our interpretation of the engineering as lifestyle perspective is that it is rooted in how little first and second year students understand about the actual practices of

engineering, mired as they are in pre-requisite courses and other disciplinary proxies for engineering (e.g., mathematics or physics). But as we see this belief continuing into data from third year interviews, we feel that there is more to it than lack of knowledge—that in fact engineering education does an insufficient job in giving students *the experience of* engineering as a meaningful craft, or that as engineers they will be able to contribute to a better world.

The second cultural belief on which we report in this paper is what we call *a meritocracy of difficulty*, a perspective we see as related to the engineering as lifestyle view. What we mean by a meritocracy of difficulty is that engineering students pervasively justify their anticipated, future, comfortable lifestyles in terms of a view that goes something like this—because their school work is so much more difficult and competitive than that of students in other departments, they deserve to live the comfortable material existence that comes from earning an engineering degree. Our analysis of the meritocracy of difficulty view is that this has been cultivated in the same void that produced the engineering as lifestyle view. Our reasoning is as follows: a) because engineering students don't yet have solid images of the actual qualities that distinguish specific engineering craft skills from other fields that would warrant a high salary and professional security, b) they must construct—as all people do as story-tellers and sense-makers about their own lives—reasons for this expected future bounty. The belief they construct is c) because they work harder now, they deserve more later.

Before proceeding with our analysis we want to offer one clarification on the use of interview transcripts as data. When people are reporting beliefs in interviews, these reports cannot simply be taken as their "true" beliefs. Reported beliefs cannot be taken entirely at face value because, as language analysts have argued, people typically also use these interactional situations to represent themselves in ways they expect will present them well to the others during interviews.¹⁻⁴

This means that there is a potential bias built into interviews that needs attention in the analysis of these types of data. We have attended to this issue in the analysis of our data, and it seems to strengthen our argument. After all, many of these students seem aware that representing money and a comfortable material existence as the reason to go into engineering is not the primary accepted rationale. In addition, our observations in engineering classes suggest that what students hear from sanctioned representatives of the discipline (e.g., faculty) is that the "right" reasons for studying engineering are not these; instead they hear things like the pleasure of solving important or challenging problems or helping others in society through one's role as an engineer. While we do hear these reasons given around the edges of students' accounts, the much more common rationale they give, as we show in the next section, is money and material reward. As evidence from the transcripts suggests, many of the students are aware of this being a less-than-perfectly-acceptable rationale and they provide some meta-commentary on giving these kinds of answers (e.g., "Money's big for me. I'm not gonna lie"). Interesting in this regard is that we find the least of this kind of overt "engineering as lifestyle" reporting at the school among our four that is easily the most prestigious. Since it is the engineering school we assume where students who complete the engineering degree should expect to earn the most, two possible explanations for this asymmetry are suggested. Perhaps students at this elite university can, at least much more than students at our other three schools, take the fact of a high salary for granted, based on expectations from their family backgrounds, the general achievement culture of the university,

and on the perceived reputation of the school. Or perhaps this engineering school is in fact doing a more balanced job of representing the craft and societal benefits of engineering work along with the lifestyle expectations.

Engineering as lifestyle

One of the questions we invited extended responses about in our yearly interviews with students is why they are pursuing engineering. We ask it in different ways, in a conversational context, and invited the students to elaborate on their initial responses as befits this style of interviewing.⁵ Based on these interviews, across our four schools and across the first three years of their undergraduate engineering educations, we have found a pervasive reported belief among many of the student participants in our study; they give as the primary reason they are pursuing engineering is to make good money and have a comfortable lifestyle. In this short paper, we offer a range of examples that exemplify this belief, but those that we include are but a portion of those in the larger corpus.

Consider first this sequence of segments from a freshman year transcript from a student, Max, at Mountain Tech:

Int: Okay cool. You had mentioned something about, you were, you thought it'd more important to work, is money something important to you, like in the future as you um get closer to getting your degree, is that//

Max: Yeah, that's a huge factor, I'm really a materialistic person, I like to spend money ((laughs)) I have three bikes, and I put a lot of money in my car. I like to buy stuff that I can use so (.) that was a big thing through high school is I wanted a lot of stuff and yeah money's a huge factor why, why I go to class every day ((laughs)).

Int: Sure, I understand that.

Max: I'm in petroleum engineering partially because of the monetary rewards, I think it'll get me-, and I think it's interesting obviously but.

Int: Mm-hmm. But that's, that's something that's a part.

Max: It's a huge part yeah. Money's big for me. I'm not gonna lie. (Max, Mountain Tech, freshman year)

This prior segment makes clear that money is a major factor in Max's pursuit of engineering. Just a bit later in the interview, he elaborates by saying,

I heard that the petroleum engineering school here is an excellent school and they have like 100% job placement and then petroleum engineering has the highest paid engineers of all the engineers and so I figured uh why not take intro to petroleum engineering ((laughs)). (Max, Mountain Tech, freshman year)

While he does ambivalently identify another reason for doing engineering, that the work is "interesting obviously", the next segment shows that other rationale fading out of his explanation in his second year, even when explicitly led by the interviewer to provide another reason that he wants to do "engineering".

Max: Mmm. That's a hard one. What's motivated me to be successful in engineering is my hopes for my life after school. My hopes for my professional life, probably the number one influential thing that I did through high school, that ((laughs)) really convinced me to get into college and work hard so I can (.) make money. Would be working all through high school

Int: mmhmm, what kind of jobs?

Max: Grunt jobs, changing oil on cars, fixing bikes, serving coffee at a coffee shop EASILY is the number one thing that motivates me to do good in school

Int: So doing jobs of that kind made it clear what you didn't want to be doing for yourself

Max: yeah easily (inaudible) yeah

Int: and is there, so about the negative motivation

Max: right

Int: on the other side did you have a positive motivation—that rocks, that's cool, I want to do that?

Max: money ((laughs)), that's about it. (Max, Mountain Tech, freshman year)

Here finally is Max, now a sophomore, telling us again he is majoring in engineering. (He had never seen his prior interview transcript nor been reminded of its specific content). The *formula* he provides for why he is majoring in engineering is surprisingly consistent across many of our research participants. It has these components; the reasons for getting into engineering are being good in high school math and science courses (but especially math), and sometimes the perception of being bad at “liberal arts classes” as in Max’s case, and the perception that engineering will provide for “at least an upper middle class lifestyle”.

Int: Well we've talked periodically about how you ended up majoring in engineering, but ((coughs)) let's come back again in terms of what got you interested, what brought you in to engineering?

Max: Probably the fact that I'm horrible at liberal arts classes. I'm good at math and science classes. ((coughs)) That's probably it. And then, my parents are engineers. Um, money.

Int: Money in what way?

Max: Money in, if I pick the right engineering discipline I can make a whole lot of it.

Int: Mm hmm. And why is that important?

Max: 'Cause I really like, I'm a really materialistic person. ((laughs))

Int: Wow. What do you imagine your money, what do you imagine being able to do with your money?

Max: Um, I intend of living a, at least an upper middle class lifestyle. Nice house, nice car, nice clothes. Nice trips, that sort of thing. (Max, Mountain Tech, sophomore year)

Interestingly, Max also provides his own comparative analysis of non-reasons for doing engineering, ruling out pleasing his parents (because they will be pleased anyway) and not because society views engineers as cool (it doesn't, in his view). It comes down, in his own comparative analysis, to money.

Max: My parents are gonna be happy with me and proud of me no matter what I do, so I'm not doing it to make them happy. I'm not doing it because society looks at engineers

as cool people, 'cause they don't. So basically, lifestyle, future lifestyle, and money.
(Max, Mountain Tech, sophomore year)

Max presents a strong example of the engineering as lifestyle perspective but perhaps too strong. Certainly most of our participants do not represent this perspective and its singularity as their rationale for pursuing engineering as dramatically, but it is a thread that runs through a vast number of our interview transcripts. Here are segments from another young man, drawn from freshman year interviews, at University of West State.

Jake's lifestyle imagery is a bit more fleshed out than was Max's in that he does not talk exclusively about making a lot of money and buying expensive things, but this is implied. What is clearer from Jake's imagery is that he sees engineering as affording an easy work life, with time for lunch with the guys and exercise. All of this for Jake would happen in an upscale part of a nice town.

Jake: ...uh, if I needed to build a submarine, I'd love it if they sent me down to Florida, work in the warm water there, build the submarine there. Uh, I'd like a nice office building that uh, like a nice pretty office building in a nice place, so a nice town. Upscale area.....so I can walk out of my office building, go down to a restaurant, grab lunch with some guys, have fun, go for a jog, come back. Uh, I want a company that treats me well as an employee, knows that I'm valuable, or thinks that I'm valuable. And um, gives me the time off that I want to, doesn't work me to death, again, and again, again. And those are pretty tall demands, but [company name] really did that for all those people, they treated em really well. (Jake, UWest, freshman year)

Thus far we have noted what we have found present in our analysis of these interviews; we find this striking especially in relation to an absence we want to note at this point and to which we return in our discussion. We find very little detailed or impassioned talk about engineering as a craft or engineering as a force of good in society. Reasons for this absence, as we have argued elsewhere,⁵ may have to do with how little direct contact students have with engineering as a distinct practice in their first years in engineering programs. During these years they are mostly taking pre-requisite mathematics and science courses, so especially in their first years we could not expect them to have clear images of the craft or social function of engineering. As we argued in our 2005 paper,⁶ this lack of productive imagery may be completely understandable but still should be a serious concern for engineering education. In the discussion, building on that argument and the data presented in this paper, we expand that point.

Erica is a chemical engineering student at UWest. In her third year interviews, she talked about her choice of a specific engineering major in this way. She highlights two reasons from information she found that led to the choice of chemical engineering—that a high percentage of people get jobs and that the starting pay is \$55,000 a year.

Int: Like online did you use the UWest Resources [Center]. Like, did you go to the department and look at what they had to say?

Erica: Yeah, I went to um- I went to the ChemE department page and also the Occupational Outlook Handbook, um online. 'Cause I wanted to know who gets paid more and all that stuff ((laughs)). 'Cause that's important. So...

Int: What did you find in the Occupational Outlook Handbook?

Erica: Um, well, ChemEs get paid a lot, but all engineers do, but the outlook for ChemEs is really good, because of the diversity. I think, like, 90% of the people with degrees find jobs. And I think it said, like, starting pay is like 55,000 a year. Sounds good to me. ((laughs)) (Erica, UWest, junior year)

Many of the women in our study express the lifestyle belief in this straightforward way, whereas for others, it is inflected by issues of other important aspects of their expected futures (i.e. marriage, family, etc.). In Maggie's third year interviews, she explains to us that the lifestyle that engineering expects is one of high pay, and implicitly security, but she discusses this in the context of how she plans to marry an engineer, so she can "stay with the kids until they go to school" and then "work part-time until they get out of school." For Maggie engineering allows a person, in this case her imagined husband, to earn enough money to allow her, projected as an equally qualified professional engineer, to stay at home with children or work part-time. The engineering-as-lifestyle perspective is differently shaded here, when compared to the unalloyed versions from Max and Jake, but our interpretation is that it is the same basic belief about the leading value of engineering—that it provides for a high salary and a comfortable lifestyle.

Maggie: If I was married with children=

Int: =You knew—You knew I was going there.

Maggie: um I've decided that if I have children either my husband or I has to stay home with the kids until um. I decided if my husband makes enough money, hence the engineer no, um ((laughter)) has to be an engineer yeah um uh. I just want it that if he makes enough money that I will stay with the kids until they go to school. And then work part-time until they get out of school. (Maggie, UWest, junior year)

A second year student at the University of Coleman explains her interest in engineering by quoting an early high school math teacher, and that teacher's comparisons of a person's life prospects with an engineering or psychology degree. As told by this student, it was these lifestyle prospects, rather than anything related to the subject matter, that "just kind of engrained what I thought I should do".

Int: Um, so, what experiences, I know we've probably talked about this last year, um, what experiences got you interested in engineering?

Lisa: Uh, well I did science, the science major in high school. I didn't go to a special school or anything, it was just a public school. We just had AP courses and I did the science track for AP courses, so I did AP Physics, AP Chem., AP Bio, and my AP Chem teacher said, "Oh my goodness. If you guys ever want to make money...." And of course I'm from an area where that is a goal. "Chemical engineering is great." And I didn't do too shabby in AP Chem, if I remember. I don't think I took the-, or if I did, I definitely didn't pass it because I wasn't that prepared by my professor-, my teachers. But she mentioned AP, she mentioned Chemical Engineering because you know, we are right around the time of [??] and terrorism and all of these things and so she just said that's the future to go in-, and my

math teacher from 9th grade was saying, “I have a, a niece who majors in psychology. She has no job. She has no future. My son’s majored in engineering. They’re getting, they come out of college \$50,000 a year.” And I’m like, “Great. So I definitely don’t want to do psychology.” So it was just kind of like engrained as what I thought I should do. (Lisa, University of Coleman, sophomore year)

Barbara, second year student at Oliver University, gave us one of the more succinct and humorous formulations about the role of money in getting through engineering and taking a salaried engineering position.

Int: So how important is the money? When you graduate, the salary, how important is that?

Barbara: I would say it’s very important, I wouldn’t kill—but it’s pretty important.

Int: You wouldn’t kill (laughs)?

Barbara: I wouldn’t—but it’s pretty important. (Barbara, Oliver University, sophomore year)

Finally in our representation of aspects of the engineering as lifestyle perspective, Ruppert, a second year student at University of Coleman, reported being surprised by the relatively small number of engineering students in the overall university population. In explaining why he thought engineering students were so rare, he expressed a viewpoint that links directly with our next section. In Ruppert’s view, “money motivates a lot of people” and since it is widely believed that engineers make good money, more seemingly should be pursuing it. What prevents this, in his view, is the difficulty of engineering, a difficulty worth noting that is over and above that of other scientific disciplines at this prestigious university. This provides a link to the second pervasive belief we discuss in this paper, what we call *a meritocracy of difficulty*.

Ruppert: Hmm, I was actually surprised by the few amount of civil engineering students there are in my classes. There’s probably, I think there’s 1,600 sophomores this year, something around that, and I see maybe 20 or 30, maybe 30 in these classes, so I feel that’s a very small percentage of all these students. Whereas, in HUM Bio, there’s about 300 students and in Bio Core there’s another 4- or 500 students and a lot of econ majors. But, then again, the few number of civil engineering students does draw respect from my other roommates and friends that I have, because if engineering was easy, I guess everybody would be doing it. (*I: How so?*) Hmm, Well, I personally think that money motivates a lot of people, so if they thought they could make money in the Engineering Department and it was very easy, that they would take the classes and graduate and go on to work for construction companies. (Ruppert, University of Coleman, sophomore year)

A meritocracy of difficulty

The engineering as lifestyle belief that we presented in the prior section was one that was in the reports of our research participants that is entirely future-oriented. In other words, our informants were talking about what they imagined their lives as engineers would or could be like in the future. In this section, we discuss a second pervasive belief, again across schools and years, that we have found in our transcript analysis. This belief is different from what we have abbreviated as “engineering as lifestyle” in that it is based on current experiences in engineering education.

This belief we call “a meritocracy of difficulty”. The basic structure of this belief, well supported by the faculty and cultures of engineering education in our broader analysis, is that engineers work harder than other people, and that working very hard is a key measure of the worth of an engineer. It, rather than a specific set of abilities, marks an engineer as meritorious. The corollary of this belief is that since engineers work harder than other people, they deserve more material gain. The meritocracy of difficulty belief therefore offers an explanation for engineers about why they deserve the lifestyle of material comfort and wealth that working in this profession affords and other professions do not.

When asked about their experience in engineering education, students in our study use no word more often than “hard”. The difficulty of engineering education in our analysis is the defining value of the experience and it is one that, as we argue in this section, organizes a number of other beliefs—including who belongs in engineering and who does not belong, how one should understand and interact with non-engineers. The meritocracy of difficulty belief organizes a status hierarchy of engineering disciplines (i.e., EE is more prestigious than Industrial Engineering because it is harder), a superiority of engineering over other disciplines (i.e., because it is harder) and most importantly for our concerns about the ways that engineering education shapes young peoples’ identities,⁶ it establishes that one is worthy of engineering only if one is willing to work extraordinarily hard and to sacrifice experiences and basic pleasures that are ordinary to other college students. In our analysis, the difficulty becomes a defining criterion of worth in its own right, rather than difficulty in service of some other functional purpose, like solving an important, challenging problem.

We begin with a segment from a first year student at Mountain Tech, describing concisely one of the sorting mechanisms⁸ that in her view is a necessary component of engineering’s meritocracy of difficulty. In this student’s view they, the unnamed faculty gatekeepers (“they”), make it hard so that engineering can sort people out and leave those worthy of engineering.

Kate: Well I think that (.) if they’re not gonna get students in here who are willing to work that hard then they don’t, they don’t belong here. And so they have to do it to get rid of the people who don’t want to work that hard. Cause that’s what engineering takes. (Kate, Mountain Tech Student, Year 1)

A great number of students across the schools report on the poor quality of teaching they receive, especially in engineering prerequisite courses. For example, here is a description of a physics course offered by Miles at Oliver University in his first year.

Miles: Physics 2, you can do the homework and still not get the material. So we’ll sit there in class and he’s just be askin’ us dumb, stupid questions in class, and then we’ll get to a test and it’ll be so hard or so complex that the class average was a 37.

Int: Wow. So he curved or something?

Miles: Don’t even know if he’s curving and he made where the test-like everything else that we do is like you have to put in answers, but it wasn’t numerical, it was like more theoretical type stuff that he was askin’ on the test. And then last year it was multiple choice, and this year he tried to make it like open answer. But it doesn’t go with his style of teaching. He’s not teaching us step-by-step to do things like that to the point where we

could do an open answer. And we sit there in class and we do all the work, sit there. It's like there's no point in even listening to his lecture. (Miles, Oliver University, freshman year)

This is a report on a course outside of engineering, but it is a common sort of report among our students, and one that we take to support our view that the meritocracy of difficulty is a pervasive view. Engineering faculty hear complaints all the time about the quality of teaching in these prerequisite courses (mathematics, chemistry and physics) but seemingly do little to correct the situation. A culture organized by a meritocracy of difficulty would expect students to endure just the sort of arbitrary difficulties that this student reports (i.e., badly misaligned instruction and examination contexts). Poor teaching becomes an acceptable test of a student's ability to survive in a meritocracy of difficulty.

A meritocracy of difficulty demands sacrifice, and across our four schools, students reported enormous sacrifices they made to survive their experiences in engineering education. Students reported giving up all sorts of things, including free time, basic relaxation, parties, and very often, sleep. Many students reported giving up other pursuits, like playing music, that until they had become engineering students were important to them. Here are some segments that represent the sacrifices that students report making, beginning with a woman at Oliver who describes giving up Spring Break simply to catch up on her engineering homework.

Int: Okay, um. So you said stressful. So how are you handling all the stress?

Louise: (.) [laughs] Um, I think I'm getting better with it. At first it was just, everything was just crazy, I was just always late and everything, and I was not gonna make it. But um during Spring Break I didn't do anything, I just took my time, caught up on schoolwork, I just basically just got myself back together, and so that helped, like I got [inaudible] I guess on top of-, more on top of things than before and I just, I try to reduce my hours at work now, because I figured, okay that's the least important thing, so it's not that serious [laughs] but I still have to keep my grades up so I just, learned to just make some sacrifices I can't do everything. (Louise, Oliver University, sophomore year)

Here Jane, a second year student from Mountain Tech describes how she uses her limited free time to do decidedly academic related extracurricular activities leaving her no time to "spend a Saturday making friends".

Jane: Um, I know the society of physics students does stuff. I haven't attended anything. I'm volunteering to do their physics bowl Saturday. As the president used to go to my high school I think – anyhow- I'm volunteering to do that. But um, there's also the society of women physicists And they try to do outings. But for the most part I don't know any of the girls, and I don't have time to go like -spend a Saturday making friends So I haven't [ventured into] any of that. (Jane, Mountain Tech, sophomore year).

When asked about a typical day, a UWest student described his day this way and elaborated on how the amount of work he did affected the rest of his life.

Int: Um so can you take us through a typical day here for you at UW?

Simon: Yeah, that's actually pretty easy. Wake up, go to work from 7:30 to 9:30, go to class from 9:30 to 12:30, eat lunch, work from 1:30 to 5. Get home, eat dinner, homework till 12 to 2, go to bed, wake up. I do that every day and then weekends I just don't go to work I just do homework.

Int: So where's the social life?

Simon: There is none.

Int: You're in a fraternity!

Simon: I know, it's ridiculous. Last quarter was a lot worse than this quarter, but. I never thought I would ever catch myself doing homework on a Friday night and it's almost a shoe-in that I do, every Friday night I'm working. (Simon, UWest junior year)

Students repeatedly report having to make choices of the kind represented in this story in our interviews with them. When one UWest student was talking about her relationship with her housemates, also college students, she told us how when they are watching a movie, she poses, instead, the following choice to herself: "when they're like watching a movie I'm like, 'Uh sleep or homework?'" Sleep or the lack thereof is a repeated theme in students' reported experiences. Having to give up a good proportion of a regular night's sleep on a routine basis is regarded as a necessary component of being an engineering student. Amelia, second-year student at Oliver described her nighttime schedule in this way and in the process made an illuminating comparison with working as an engineer in industry, which she regarded as decidedly *less difficult than engineering education*. This is an important idea that other students did not articulate as directly as Amelia, but we infer would be common given the engineering as lifestyle view we described. Students expect life and work to be *easier* if they get through engineering education and go on to practice engineering. If this inference is right, it further supports our meritocracy of difficulty interpretation.

Amelia: It takes up a lot of time, and I was like, when I first came here I'm like I'm not gonna be in the engineering building to four o'clock in the morning, but once you hit your junior year, or sophomore year you start being in here like six o'clock and you gotta be back by eight so yeah, it's definitely hard.

Int: You've got a full time job, huh?

Amelia: Yes, it is. It's, it's better working in the industry than it is going to school.

Int: Is it, yeah I believe it.

Amelia: Yeah

Int: I believe it. No homework, huh sometimes.

Amelia: Exactly, exactly. (Amelia, Oliver, sophomore year)

Another effect of the meritocracy of difficulty in engineering education is that it made clearly intelligent people, who had success in high school and were all attending relatively elite universities or colleges, question their intelligence and their ability to make it through school.

During a first-year interview, Ingrid, a student at Mountain Tech described the insecurities she felt her first semester in college. Notable in the second segment is how after locating herself "so

dumb” in comparison to the “smartest kids” she also located herself above those students “who don’t try as hard as I do” and this she reported as making her feel better.

Ingrid: At the, the very first, like the first semester, um, and after that, I was just flipping out that I, I didn’t know how I was gonna get through this school, um, you know and I’m sure that the first year is the hardest, just having to understand, you know, how college even works. Um so back then I was really scared that I wasn’t gonna make it through this school. ...Um, that I got through the first semester yeah, that put me really-, I mean, because I think I just beat myself up quite a bit too because I compare myself to, um, you know, some of the smartest kids in the school and I feel just so dumb, because these are, all the kids that go here are top-notch students, um, at least grade levels. And um, but then you know I also compare myself, I have to remember to compare myself to a few other people who don’t try as hard as I do, you know, and then that makes me feel better, a lot better inside that, “That’s okay [name] you know, you’re doing just fine,” don’t worry. (Ingrid, Mountain Tech, freshman year)

This insecurity effect was just as operative at the most elite school in our study, one of the most elite engineering schools in the nation. A second year student at University of Coleman described how hard he worked in an introductory physics course (a prerequisite for the engineering major), but still felt imperiled by the uncertainty of where the inevitable “curve” would be placed by the professor. This student felt that he worked very hard and deserved not to “fail” on the basis of his extraordinary efforts. The “curve” then appears as a piece of educational infrastructure that supports the meritocracy of difficulty, in that it can be placed in such a way that some are guaranteed, no matter their efforts, not to survive.

Darnell: But I guess [Intro to Physics] just really hit hard because everyone else was more prepared than I was. And there were a couple other students in my same situation, too, and I, we had all talked about it and really thought that we were working really, really hard and it was just very tough because the means were quite high, and we feel that a lot of that was because they’d had a lot more prior preparation. And I guess it added on to stress, because myself and others included who hadn’t had the previous experience kind of really felt the pressure of, “What if we fail this course?” Like, we’re working so hard that there’s no reason why we should fail, but when everything’s added up, we’re just one, or we’re just a number in a class of 400. It’s like how, you know, we had no idea how many people, if anyone, ever fails the physics classes, but we definitely felt it should not be us, by the measure of work we were doing. We were...but there was still that kind of underlying uncertainty, because you never know how a class is going to be curved. There’s really no other indication, other than, like, how you’re doing representative to everyone else in the class. Other than that, there’s no indication of if you’re at risk or anything. And I think it just added undue stress. It’s like we were working really, really hard; I think we shouldn’t have had to worry about that but we did. (Darnell, University of Coleman, sophomore year)

One of the most significant implications of the meritocracy of difficulty in engineering is how it led engineering students to distinguish themselves from students in other majors and to place their discipline in a clearly superior position to others. This is a particularly interesting

phenomenon, because engineering education at each of our four schools, except one, demands a course schedule such that students have almost *no* actual experience of courses in other non-engineering disciplines. What engineering students do experience, usually in the context of roommates with other majors, are apparent dramatic differences in the difficulty of work they must do and the amount of time they must commit to their official school work. Thus, we interpret the “boundary work”⁹ that engineering students do in their interviews as part of the meritocracy of difficulty idiom they are learning.

Three examples of this kind of boundary work, which we found consistently in the speech of students across the four schools, are offered here. In the first, a University of Coleman student talks about how students in other majors are readily identifiable because they do, and talk, about things other than engineering. In the second, a student from Oliver talks about students in other majors should all have 4.0s because “cause their work is very easy”. In the third, a junior at UWest offers a more qualified contrast, but still claims that easier engineering classes are harder than classes in other majors.

Walt: Also, it seems like engineering students tend to be more absorbed in their major, while non-engineering students tend to be exploring a lot of different stuff and trying on a lot of different things. Like, I don't know, like if you talk to an engineer for a little bit, it's pretty clear that he's an engineer and there's even, it might even become clear which field of engineering he's doing or he or she is doing. But if you're talking to some non-engineering person, like there's a, their major, or whatever, it's not really, won't become obvious. I don't know, like their major isn't as big a part of their lives, like the fact that they're doing poly sci. or econ. isn't really that, doesn't really make that much of a difference when you're talking to [unclear]. It just seems like engineering is a more, a major that kind of like absorbs people and kind of, I don't know, just it's something that requires a lot more, it's just because maybe it requires a lot more time, it just, it's a, it, you know, it becomes a bigger part of you than a major might for a non-engineering person. (Walt, University of Coleman, sophomore year)

Eleanor: I think that engineering students are stressed. And they are, they have a lot of work to do they, I-, s-, [inaudible] myself and my roommate, like I'm a engineering student this last semester, this semester, and she's a, a communications major, and she, I never see her do any work. And she'll always ask me, “Why you have so much work to do?” She always see me, uh, do homework, sitting at the computer, and I always see her on the phone, out of the room, going somewhere, bringing friends in the room. But me, I'm always doing my work. And I just think that students in other majors, they're like, their major, they don't, they should easily have a 4.0, I think that they should easily have a 4.0 cause their work is very easy. (Eleanor, Oliver University, freshman year)

Int: Um, what about non-engineering students? Um, would you say that there are things that distinguish engineering students from students in other majors?

Bryn: I think we have to study more, I really do. I—I know that I'm not even in like a hard engineering and I study more than my roommate does, or our other friends. I mean, it's—it's different when you're taking the English class or a uh, a cultural class, I mean, you could—those are things that—some of it you already know, I mean. Um, but when

you're taking a thermodynamics class, that's not stuff people know about everyday. I mean, that is stuff that is some serious, you know, it's hard. Um, I—I—the sciences are hard. I'm not just saying engineering, science, too, um, but the more—the lib—the liberal arts classes that are sciences, theirs are um, hmm, there just different, they are. They're not um, I just don't think they're as time demanding and they—there's—they demand you to think in a different way, so. (Bryn, UWest, junior year)

When students elaborated on the differences in content across engineering and other majors—beyond what they saw as the irrefutable difference in time demands—they often talked about the sorts of things Bryn did: that things you learn in an English or “cultural class” are sometimes things “you already know”. At the University of Coleman a student talked about ease of writing papers, because what you write “doesn't have to be true” and that you could take some percentage of quotes that you use in a paper and make a strong argument for something completely different.” Other students often dismissed the work of other subjects as merely “subjective” and therefore easier.

Students in our study also reported that engineering faculty reinforced engineering's merits in relations to other disciplines. Of course, we should expect to see boundary work among all disciplines. Our point is not that the boundary work in engineering is unique (i.e. people in other fields do it too), but that it is uniquely focused on difficulty as a quality that distinguishes it as superior.

Jamie: I, it's just, it's kind of weird, like but there's definitely-, and I also noticed it with my, um, academic advisor who's an engineer, like he's definitely kind of like, you know ha-, has this kind of attitude of like, “Oh engineering was hard, and like, all those other majors, nyeah, they-, they didn't have to do anything,” and so like, um, I think that's another reason why I kind of like so-, I, I mean not on a conscious level, like but maybe on a more subconscious level like kind of had that kind of engrained into me and it's like, “Oh, go for the techiest of the techy, cause like that'll be really hard and like.” (Jamie, University of Coleman, freshman year)

Taken together, these and other segments from interviews conducted with engineering students at four universities across three years lead us to see “the meritocracy of difficulty” to be a pervasive belief in engineering education. It organizes how students spend their time, explains to them why they make extreme sacrifices at a time of life when they are first on their own, and isolates them from people in other majors because of their views that these students' lives were much easier. There was a clearly negative moral judgment associated with this attribution of relative ease. Other students reported not being able to relate to students in other majors, while others talked about degrees of resentment they felt towards the students in other majors that they believed had easier work and better lives.

Discussion and implications

It appears to be a universal feature of human discourse that people of shared experience develop shared ways to explain their position and direction in life. Given our analysis that suggests both a meritocracy of difficulty and engineering as lifestyle as pervasive beliefs among engineering

students, we hypothesize that one available discourse for engineering students to explain their position in their current and future lives involves linking these two beliefs in the following way: students in other majors have easier and better lives, so there must be some reward—in the future—for the sacrifice and hard work that is unique to engineering education. This reward is a high paying job and a comfortable lifestyle.

There is, in some sense, nothing unusual about this formulation; it is part of an American idiom that runs at least back to the writings of Benjamin Franklin. His famous epigram “Early to bed and early to rise makes a man healthy, wealthy, and wise” captures this perspective, though in the case of engineering students he would likely have needed to delete the “early to bed” part. Weber’s famous formulation of the Protestant work ethic¹⁰ also comes to mind. Weber argued that the Protestant work ethic was the motor that drove the rise of capitalism in Northern Europe. Where the Protestant work ethic differs, with its focus on hard work and earning more and more money, is that the paradise that hard work promises is a decidedly more earthly one for engineering students.

Yet we worry about this combination of beliefs in the context of some of the goals we believe to be widely shared within the engineering education reform community. One of those goals is clearly to promote an image of engineering as a force of good in the world—that leads to new socio-technical systems, of all shapes and sizes, that improve people’s lives and the lived environment. We must say that even though this message is out there among the many messages that engineering students hear and see in their college experiences, it seems to have very little hold over them. Perhaps, we speculate, students don’t quite believe this about engineering, because it is only something they have heard but not experienced in their own experience of doing engineering.

A second goal of engineering education reform, related to the first, is that engineers should design better for people and the world, because they understand it better. Such a goal would we assume involves close contact with people and the world. Therefore, the distancing from other people that the meritocracy of difficulty appears to produce and the sacrifices students report making in all other parts of their lives does not bode well for achieving this goal. The students in our study are largely isolated from learning about the rest of the world (either through course work in other disciplines or other experiences that make a well-rounded person) by the all-consuming work load in engineering courses, and they develop ways of seeing themselves as a group apart from others, even others seemingly quite similar to them (i.e. college students at the same university).

Another goal of engineering education is to include people from more diverse backgrounds in the practice of engineering. The experiences of difficulty and sacrifice we described here, along with the fact that even the most accomplished students at the most prestigious schools doubt that they can make it, make the meritocracy of difficulty seem a counterproductive force for achieving this goal.

Some who would likely call themselves realists would say that the meritocracy of difficulty is a simple and necessary outcome of two “hard” facts—engineering IS this difficult and all that students are required to learn in college is absolutely necessary to ensure that they can practice

professional engineering. There are good reasons to doubt the factual status of both of these claims.

For nearly 50 years, scholars of learning have been questioning whether seemingly arcane subjects like calculus, physics and chemistry are necessarily hard or whether they are just taught that way.¹⁰ In addition, we really should examine closely the question of whether everything that is packed into engineering education needs to be there. The unforgiving pace and volume of work seems to have a lot to do with the experience of difficulty that students experience. In other research we are doing currently and have done in the past, we compare the “work” of engineering education with the “work” of professional practice. Not surprisingly, since it is an open secret among practicing engineers, only a fraction of what people do in undergraduate engineering education gets used in practice and much that is needed in professional practice is never taught or learned in engineering education. And regardless it is an open question whether the pace and volume of the material that students encounter in engineering education ever gets learned in any deep and usable way at all.

The line of analysis that we have taken in this study lead us to two substantive recommendations for engineering education. Both are somewhat vaguely formulated at this point, but we believe they do offer clear guidance. We invite further collaboration and conversation with engineering educators about how to translate these general recommendations into programmatic action. The first recommendation is to try to establish ways that students can have, through *experience* in engineering education, other leading reasons to become engineers than a comfortable lifestyle. As we have said, students do give other reasons and we have no reason to doubt that they are sincerely held, but these other reasons are greatly eclipsed by money and lifestyle as reasons given for why contemporary students across the nation pursue engineering. We would describe these other reasons (e.g. “interesting” work) as *hopes* whereas a comfortable material existence and high pay are *expectations* that hold them steady to navigating through engineering education. On this point, we might compare engineering with architecture—a comparatively low paying field—because architecture students seem to experience similar time commitments to engineering students. Architecture students however seem to have a counterweight to the experience of time and sacrifice that seems required, which is a shared belief that they are learning quite specific craft skills and coming to participate in a practice that has a long and storied history.¹¹

A second recommendation to which we are led from this study is more dramatic. We believe engineering education ought to deeply examine how much of its curriculum can be “weeded out” as unnecessary for whatever reason. This weeding out in our view, would allow the educational experience of college students to be less packed and more focused. Students might, as comparative international research has found about mathematics education in K-12 (TIMMS), actually have a more usable conceptual and practical repertoire than they do currently. This investigation of a true core of engineering knowledge—in this age of distributed teams and technologies that off-load a good deal of calculation labor—could be a defining feature of the next generation of engineering education.

Engineering education may never be easy but, in fact, no form of work performed well is. But it may be an artifact of the meritocracy of difficulty and the general entropic process of how

curricula evolve over years that makes it as hard as students currently experience it. We also believe that engineering education could do a much better job establishing what the craft of engineering is as form of usable knowledge for students and what engineering can do to improve the socio-technical systems that are ubiquitous in our lives. This would allow young people who are becoming engineers to be able to talk with other people about what they do and expect them to say “wow” not only or even mainly because it’s hard, but to say “wow” because it is interesting and changes the world for the better.

References

- [1] Polanyi, L. (1989). *Telling the American story: A structural and cultural analysis of conversational storytelling*. Cambridge, MA: The MIT Press.
- [2] Schiffrin, D. (1994). *Approaches to discourse*. Oxford: Blackwell Publishers.
- [3] Duranti, A. (1997). *Linguistic anthropology*. Cambridge, UK: Cambridge University Press.
- [4] Goffman, E. (1959). *The presentation of self in everyday life*. Garden City, NY: Doubleday.
- [5] Mishler, E. (1990). *Research interviewing: Context and narrative*. Cambridge, MA: Harvard University Press.
- [6] Stevens, R, K. O’Connor, and L. Garrison. (2005). Engineering student identities in the navigation of the undergraduate curriculum. *Proceedings of the American Society for Engineering Education Annual Conference*, Portland, OR, 12-15 June 2005.
- [7] Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge, MA Harvard University Press.
- [8] Gieryn, T. F. (1983). Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists. *American Sociological Review*, 48(6).
- [9] Weber, M. (1958). *The Protestant ethic and the spirit of capitalism*. New York: Scribner.
- [10] Bruner, J. (1960). *The Process of Education*. Cambridge, MA: Harvard University Press.
- [11] Cuff, D. (1991). *Architecture: The Story of Practice*. Cambridge, MA: MIT Press.