

AC 2010-129: TRAINED TO DISENGAGE? A LONGITUDINAL STUDY OF SOCIAL CONSCIOUSNESS AND PUBLIC ENGAGEMENT AMONG ENGINEERING STUDENTS

Erin Cech, University of California, San Diego

Erin Cech's research examines individual-level, cultural mechanisms that reproduce inequality, especially those pertaining to sex segregation in science and engineering fields. Her dissertation explores the self-expressive edge of inequality, analyzing how gender schemas and self-conceptions influence the career decisions of college students over time. Her other work examines the experiences of lesbian, gay and bisexual engineering students (with Tom Waidzunas), the work devotion of and perceptions of inequality among high-level professional women (with Mary Blair-Loy), and cross-national beliefs about work time for mothers (with Maria Charles). Cech is a member of two NSF-funded research groups: "FuturePaths" (with Carroll Seron, Susan Silbey, and Brian Rubineau), which examines the professional socialization and persistence of engineers; and a team exploring the gendered experiences of Native American students in Science and Engineering (with Anneke Metz and Jessi Smith). She earned bachelors degrees in Electrical Engineering and in Sociology from Montana State University.

Trained to Disengage? A Longitudinal Study of Social Consciousness and Public Engagement among Engineering Students

Abstract

Much has been made of the importance of training ethical, socially conscious engineers, but is engineering education actually succeeding in this task? Does the professional socialization of engineering students train them to take seriously their professional responsibility to public welfare? This paper examines this vital question by systematically testing whether programs successfully emphasize ethical, engaged engineering practice to their students, and whether such programmatic emphasis actually cultivates in students a sense of social consciousness and a belief in the importance of their professional engagement in public welfare. This paper utilizes unique quantitative longitudinal panel data which follow cohorts of engineering students at four diverse institutions (MIT, UMass, Smith and Olin) for four years. In order to determine if professional socialization cultivates engaged and socially conscious engineers, I analyze (a) whether engineering programs actually emphasize ethical engagement in issues of public welfare, (b) whether students' social consciousness and belief in the importance of public engagement increase over the course of their college careers, and (c) whether programmatic emphasis is causally related to these changes. The results suggest there is much work to be done: Not only do programs *lack an emphasis* on ethical engagement, this lack of emphasis is causally related to a *reduction* in students' social consciousness and their belief in the importance of public engagement over the course of their college careers. The silver lining to this story is that professional socialization does appear to be effective at changing students' beliefs. If programs are able to increase their emphasis on ethical engagement, this research suggests that engineering programs have the capacity to produce more publically engaged, socially conscious engineers.

I. Introduction

Professional occupations like engineering have a special responsibility to the public they serve.¹ Professions have a virtual monopoly on entire areas of social life, allowed to *define* and *construct* particular areas of social reality.^{1, 2, 3, 4, 5} Because of their unparalleled influence in the complex technical systems pervading post-industrial society, engineering professionals are obligated to engage in work that serves the public good and to engage with issues of public welfare when such issues come into contact with their professional domain.⁴ Professionals acknowledge the societal obligations bestowed upon them by learning and following formal and informal codes of ethical practice.⁶ A responsibility for taking public welfare into account as they practice engineering is central to the professional duties of the engineer: "Engineers hold paramount the safety, health and welfare of the public in the performance of their professional duties...should engineers' professional judgment be overruled under circumstances where the safety, health and welfare of the public are endangered, the engineer shall inform their clients or employers of the possible consequences and notify other proper authority of the situation."⁷

Learning the ethical practices and behaviors of the engineering profession, and the weightiness of the responsibilities therein, is a fundamental component of engineering education. This training is integral to *professional socialization*, the process by which professional skills and

identities are cultivated in neophytes. The importance of producing engineers who take their professional responsibilities to the public seriously has resonated through engineering publications and regulations in the last decade, exemplified in the increased emphasis in ASEE on ethics and ethics education, the National Academy of Engineering's *Engineer of 2020* publications, and ABET's EC2000 accreditation criteria.^{8,9,10} The development of students' social consciousness and public responsibility is also a recent "core concern" of US Higher Education more broadly.¹¹

This paper asks, is this professional socialization working? Does engineering education instill in engineering students the importance of their responsibilities to the public? More specifically, *do engineering students emerge from their experiences in engineering education more socially conscious about the effects of their engineering work and more engaged with issues of public welfare than when they entered?* Using longitudinal panel surveys collected by an NSF-funded project called "FuturePaths," I follow cohorts of engineering students at four institutions (MIT, the Franklin Olin College of Engineering, Smith College, and the University of Massachusetts—Amherst) from the time they enter their engineering programs through their fourth year in their programs. This paper uses these unique data to examine the *changes in* students' social consciousness and commitment to public engagement over their four years in undergraduate engineering programs. These data provide a rich and robust study of students' professional socialization because they follow the same students over time, they have measures of how well programs are doing at emphasizing public engagement and social consciousness, and they include samples from four diverse engineering programs representing the variety of engineering education in the United States.

This paper examines two specific measures of students' commitment to issues of public welfare: (1) the importance to them of engagement with public welfare issues as they practice engineering (the *importance of public engagement*) and (2) whether they consider it personally important to improve public welfare (*social consciousness*). I also consider the extent to which students' engineering programs emphasize engagement in public welfare and ethics issues (*programmatic emphasis on ethical engagement*). This measure is important because it allows me to determine the extent to which any changes in students' beliefs are attributable to their program's emphases, rather than the myriad other maturation and life-changing processes typically encountered by undergraduate students.

After describing these three concepts and the professional socialization process, my analysis proceeds as follows: first, I examine how respondents perceive their programs' emphasis on ethical engagement. Next, I determine how respondents' public engagement views and social consciousness change over the course of their undergraduate engineering education. Finally, I analyze how programmatic emphasis is causally related to these changes in public engagement views and social consciousness. If engineering programs are indeed cultivating a sense of professional responsibility to public welfare in their students, then students' public engagement and social consciousness scores will increase over the course of their college careers, and the programmatic emphasis measures will be casually related to these changes.

I find that students' professional socialization process is indeed an effective driver of their views on public engagement and their social consciousness, but not in the direction hoped for: students

emerge from their engineering programs *less* interested in a career that is engaged with public welfare issues and less socially conscious than when they entered. These changes are causally related to the lack of emphasis on ethical engagement in students' engineering programs. This paper ends with a discussion of these important findings and their policy implications.

Professional Socialization

Professions have several characteristics that distinguish them from non-professional occupations: professions are deeply institutionalized; have specialized training, credentialing and education processes, organized associations and codes of ethics; and their expertise is legally sanctioned.⁶ Although engineering is often contrasted with more traditional professions such as law and medicine, the structure, credentialing, and regulation of engineering is consistent with this definition of a profession.

Because of the dearth of research on professional socialization in engineering, I rely on literature that examines professional socialization in law, medicine and business. Although the processes of professional socialization are different in engineering than in professions that have stand-alone professional schools, undergraduate engineers certainly experience an intense professional socialization process. Unlike most other professions, engineering students must emerge from their four years of undergraduate education ready to be practicing representatives of their profession. Therefore, undergraduate engineering must provide that professional socialization, whether or not students plan to pursue advanced engineering degrees.

The existing professional socialization literature clearly demonstrates that becoming a professional is more than the mastery of technical competence or expert knowledge.^{1, 12, 13} To the extent that professional socialization is a process of preparing the neophyte to go out into the world to earn a living, it involves the cultivation of "practical skill" as well as the nurturing of a "professional identity."^{14, 12, 15} Learning "practical skill" translates into hands-on understanding of the challenges faced in working with uncertainty.¹⁶

Professional socialization is the process by which students learn and adapt to a new culture that involves comfort in working effectively with social uncertainty, and, in accordance with formal and informal codes of ethics, recognition that one has a broader set of responsibilities to society.^{16, 17, 13} Emersion in a professional culture involves learning and inculcating a "web of values, norms, rules, beliefs, and taken-for-granted assumptions" which helps students to develop the "habits of mind" of a committed professional.¹⁸ Through classes, internships, research with faculty, summer jobs, assignments, involvement in student chapters of professional organizations, hall talk and friendships, students are transformed into a "professional" as they adapt values and norms, identify with particular symbols, and learn to project a confident, capable image to the public.^{1, 16, 19, 20, 10} This socialization process is so vital because it is "crucial to both professional identity (marking oneself as an engineer with rights to speak authoritatively in the profession) and competence (getting engineering work done)."²¹

The effects of professional socialization go beyond students' perceptions of the engineering profession and engineering work. It is deeply attitudinal in nature, and the culture, skill and etiquette of a professional appear in the individual as *personal traits*. The longer they spend in

the initiation process, the more firmly impressed upon students are the values of the profession.^{22,}
²³ Engineering students, in short, “learn to be” engineers.¹

Learning to be an ethical engineer, therefore, requires more than simple memorization of a code of ethics. Engineering programs must provide students with tools for identifying and questioning their role in society, practice thinking through challenging ethical situations, and most vitally, impress upon them the importance of their responsibility to public welfare.

I examine three dimensions of this programmatic emphasis within professional socialization: the importance to engineering programs of ethical and social issues, of broad education in the humanities and the social sciences, and of the policy implications of engineering work. These emphases together capture a sense of “ethical engagement” in public welfare issues. Programs that emphasize ethical engagement take seriously the ethical and social issues embedded in engineering practice, encourage a broad education outside of engineering to hone students’ cultural awareness and critical thinking skills, and push students to consider the policy implications of their engineering work. I tap programmatic emphasis at the “receiving” end (students’ perceptions of their programs) rather than the “sending” end (faculty and administrators’ perceptions of how they educate students), because students are ultimately the active consumers of the professional socialization process. Even if faculty and staff believe they are succeeding at socializing students to understand their social responsibilities, students may not be receiving that message.

Public Engagement and Social Consciousness

I examine two sets of outcome variables: the extent to which students’ perceptions of a successful career value public engagement, and the extent to which students find improving public welfare personally important (their social consciousness). Professional socialization inculcates students in understandings of what makes up a successful career in engineering; public engagement is one of many beliefs students may develop about what makes a successful engineering career. By “engagement” I mean engineers’ role of valuing and thinking critically about the social impacts of the technologies they and other members of their profession create, with the assumption that they will fulfill the role of “whistleblower” if they believe the “health and welfare of the public” is endangered.^{3,24} The “importance of public engagement” measure captures the extent to which students find their professional and ethical responsibilities important and whether they believe it will be important in their future engineering career to understand the social consequences of technology and how people use machines.ⁱⁱ

Professional socialization is a process that changes not only how students understand the profession and their future career therein, it also alters the personal values and traits of these students.^{1,23} The “social consciousness” measure taps the *personal importance* to students of improving society, helping others, participating in their communities and easing racial tensions. If professional socialization is effective, students should emerge from their undergraduate experiences more interested in public engagement and more socially conscious than when they entered as freshman. The analysis below will not only be able to track these changes, but determine if a programmatic emphasis on ethical engagement actually drives these changes.

Undergraduate students face a formative time in their lives and these beliefs may change for many reasons (e.g. roommates and friends, campus life, non-engineering classes) other than their experiences with engineering. The data on programmatic emphases allows me to test how much of those changes are attributable to programmatic emphasis, and not other factors.

II. Data and Methods

The sample consists of 245 students who entered engineering programs in 2003 at four universities: Massachusetts Institute of Technology (MIT), the University of Massachusetts at Amherst (Umass), the Franklin W. Olin College of Engineering (Olin) and Smith College (Smith)ⁱⁱⁱ. The sample is 43.2% women and 32.2% of the sample identify as a member of a racial or ethnic minority. Of the 245 students, 36% attend MIT, 22% attend Smith, 22% attend Olin, and 20% attend UMass. Students were surveyed via web surveys each year for four years. Key attitudinal variables were repeated in multiple survey years. Though the proportion of the sample enrolled in each type of institution (elite private college; large, public land-grant institution; engineering-only college; and single-sex college) does not match the proportion of engineering students nationwide enrolled in each type of institution, the diversity of institution types in this sample allows for a broad examination of the effectiveness of professional socialization across the spectrum of engineering education. Future research will examine the differences in professional socialization among these institutions, as well as differences by gender.

Independent Variable: Programmatic Emphasis on Ethical Engagement

The key independent variable, students' perceptions of how strongly their programs emphasize engagement with issues of public welfare, is a scale variable ($\alpha=.718$) created by summing the following three variables and dividing by three: "Importance to your program of ethical and/or social issues" (1=very unimportant to 4=very important), "Importance to your program of broad education in the humanities and social sciences" (1=very unimportant to 4=very important), and "Importance to your program of policy implications for engineering" (1=very unimportant to 4=very important). Though their coefficients are not shown in Tables 2 through 4, all models control for variation by school and by gender. Future research will explore these group differences

Dependent Variables: Importance of Public Engagement and Social Consciousness

The models below examine students' commitment to public welfare through two sets of measures: whether students consider engagement an important part of a successful career (*importance of public engagement*) and whether respondents consider improving public welfare personally important (*social consciousness*). I examine the changes in students' responses to these measures between year 1 and either year 3 or 4, depending on the measure. I am also interested in the extent to which the programmatic emphasis measures are causally related to these changes over time.

The importance of public engagement measures ask respondents the "importance to a successful career" of the following characteristics: "Professional and ethical responsibilities" (1=very

unimportant to 5=very important), “Understanding the consequences of technology” (1=very unimportant to 5=very important), and “Understanding how people use machines” (1=very unimportant to 5=very important). I also created a scale variable for the importance of public engagement ($\alpha=.650$) by summing these measures together and dividing by three. Public engagement questions were asked in year 1 and year 3. As explained below, I use both year 3 values of these variables and the delta (change) scores for each respondent by subtracting the year 1 value from the year 3 value.

The social consciousness measures ask respondents the “Personal importance to you” of: “Improving society” (1=very unimportant to 4=very important), “Being active in my community” (1=very unimportant to 4=very important), “Helping promote racial understanding” (1=very unimportant to 4=very important), and “Helping others who are in need” (1=very unimportant to 4=very important). I also created a scale variable for social consciousness ($\alpha=.801$) by summing those measures together and dividing by four. Social consciousness measures were asked in year 1 and year 4, so I utilize both year 4 social consciousness measures and social consciousness delta scores (subtracting year 1 from year 4).

Analytic Strategy

I look for the existence of a programmatic emphasis on ethical engagement and the effects of that emphasis on students’ beliefs by using standard bivariate statistics and Ordinary Least Squares (OLS) Regressions. In order to claim that professional socialization in engineering education successfully cultivates in students the importance of public engagement and a sense of social consciousness, I would need to find three trends: (1) students must perceive that their programs emphasize ethical engagement, (2) students’ public engagement and social consciousness scores must increase over time, and (3) programmatic emphasis must be causally related to these increases.

After presenting a series of bivariate statistics, I ran two sets of OLS regressions: one where programmatic emphasis (as an independent variable) predicts students’ career engagement and social consciousness in year 3 or 4, and another set where programmatic emphasis predicts the *changes in* students’ public engagement views and social consciousness between year 1 and year 3 or 4.

Because the change in students’ perceptions of their program’s emphasis on engagement may also affect students’ career engagement and social consciousness values, I ran additional OLS models with the programmatic emphasis delta score (year 3 – year 1) as the key independent variable.

III. Results

Table 1 presents the descriptive statistics for the programmatic emphasis, importance of public engagement, and social consciousness variables in year 1 and year 3 or 4, and their delta scores. The program emphasis variables illustrate that, in general, students do not perceive that their programs emphasize ethical engagement. Most of the means on the first three program emphasis variables (ethical/social issues, broad education, and policy implications) sit just below a value

Table 1: Mean Values on Key Independent and Dependent Variables, by Year and Delta Score

<u>Program Emphasis Variables</u>			
<i>Importance to your program of....</i>			
<i>(1=very unimportant to 4=very important)</i>			
	<u>Y1</u>	<u>Y3</u>	<u>Delta</u>
Ethical and/or Social Issues	2.81	2.95	.14
Broad Education in Humanities and Soc Sciences	3.08	2.98	-.10
Policy Implications for Engineering	2.91	2.68	-.37
Ethical Engagement Scale ¹	2.94	2.82	-.11
<i>Technical and Theoretical Emphases:</i>			
Foundations in Math and Science	3.73	3.76	.03
Basic Research	3.29	3.27	-.02
Inventions and Industrial applications	3.24	3.24	.00
Innovation	3.46	3.42	-.04
Scientific Advancement and knowledge	3.45	3.42	-.03
<u>Importance of Public Engagement Variables</u>			
<i>Importance to a Successful Career...</i>			
<i>(1=very unimportant to 5=very important)</i>			
	<u>Y1</u>	<u>Y3</u>	<u>Delta</u>
Professional and Ethical Responsibilities	4.31	4.19	-.12
Understanding the Consequences of Technology	4.39	3.94	-.45
Understanding How People Use Machines	4.28	3.55	-.73
Importance of Public Engagement Scale ²	4.35	3.89	-.46
<u>Social Consciousness Variables</u>			
<i>Personal Importance of...</i>			
<i>(1=very unimportant to 5=very important)</i>			
	<u>Y1</u>	<u>Y4</u>	<u>Delta</u>
Improving Society	3.32	3.24	-.08
Being Active in My Community	2.87	2.68	-.19
Helping Promote Racial Understanding	2.59	2.20	-.39
Helping Others Who Are in Need	3.11	2.89	-.22
Social Consciousness Scale ³	2.90	2.72	-.18

¹ The “Ethical Engagement Scale” is made up of the three ethical engagement programmatic emphases variables, summed and divided by 3 (alpha=.718)

² The “Importance of Public Engagement Scale” is made up of the three public engagement variables, summed and divided by 3 (alpha=.650)

³ The “Social Consciousness Scale” is made up of the four social consciousness variables, summed and divided by 4 (alpha=.801)

of three, “somewhat important.” This is in contrast to program emphases on more technical or theoretical aspects of engineering included in Table 1 for purposes of comparison. Students perceive that their programs emphasize scientific advancement, invention and industrial applications, innovation, and basic research to a greater extent than ethical engagement. Figure 1 illustrates the difference in emphasis between ethical engagement factors and the theoretical or technical factors. This discrepancy is not surprising from the perspective of traditional conceptions of engineering practice, as engineers’ time is taken up far more with concerns of innovation and research than policy implications, but it is counter to new movements in engineering education—particularly at new programs such as Olin and Smith—which attempt to explicitly emphasize ethical engagement.^{9, 25} Also, students’ perceptions of their program’s

emphasis on ethical engagement fluctuates between year 1 and year 3 more than the measures of emphasis on science and innovation-related issues. In Figure 1, all but one of the ethical engagement measures are lower in year 3 than in year 1, compared to the theoretical and technical emphases, which remain nearly stable over time.

These results indicate that the schools in my sample do not have a programmatic emphasis on ethical engagement (as the mean values sit between “somewhat unimportant” and “somewhat important”) and seem to de-emphasize ethical engagement relative to theoretical and technical issues (which all sit between “somewhat important” and “very important”).

Figure 1: Programmatic Emphasis on Ethical Engagement, Compared to Emphasis on Technical and Theoretical Issues

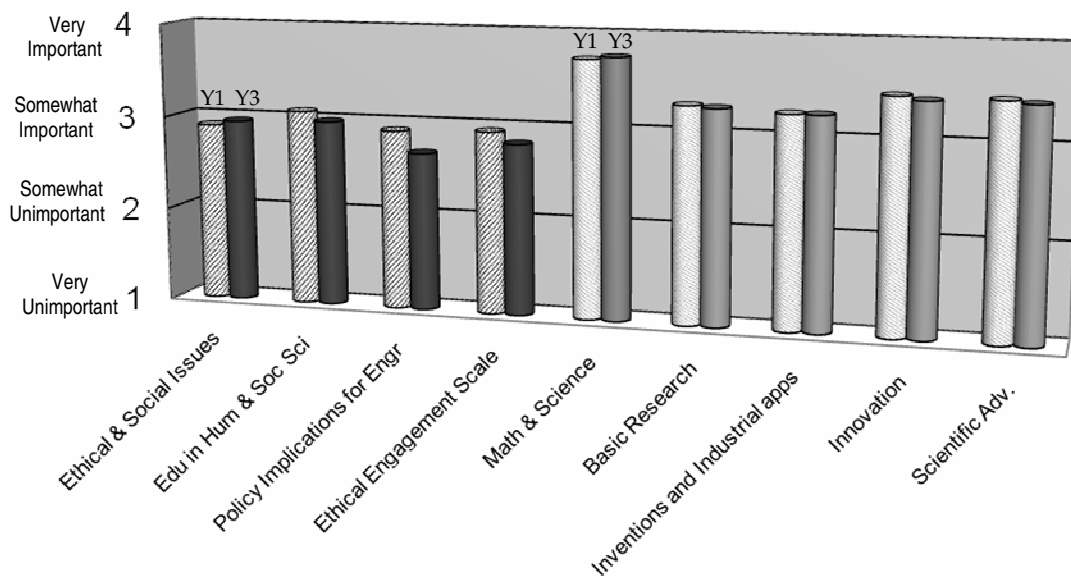


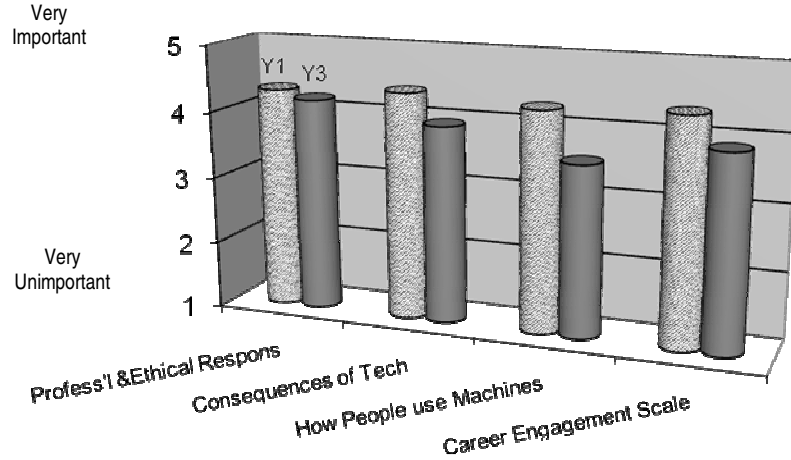
Figure 2 illustrates that respondents’ understanding of the importance of public engagement in a successful career changes substantially between year 1 and year 3. Over the course of their first years in the engineering profession, their perception of the importance in a successful career of professional and ethical responsibilities, understanding how people use machines, and understanding the consequences of technology all *decrease*. The career engagement scale, a variable combining these three measures, decreases by nearly half a point.

Table 1 shows that respondents are less personally interested in improving society, being active in their community, promoting racial understanding, and helping those in need at the end of their college experiences than when they entered (see Figure 3). These students emerge from what is supposed to be an experience of “enlightenment” *less socially conscious* than when they arrived.
26, 27

The question, then, is: does the lack of emphasis on ethical engagement in respondents’ engineering programs cause these decreases in public engagement and social consciousness?

The next sets of analysis examine the significance of the relationship between programmatic emphasis and engagement and social consciousness variables—in other words, the extent to which programmatic emphasis causes these changes, and not other factors. I run OLS regression models using programmatic emphasis on ethical engagement (the “Ethical Engagement Scale”) as an independent variable predicting both the *strength* of public engagement and social consciousness in year 3 or 4 and the *direction of change* of these measures.

Figure 2: Importance of Public Engagement, Year 1 and



3

Figure 3: Social Consciousness, Year 1 and 4

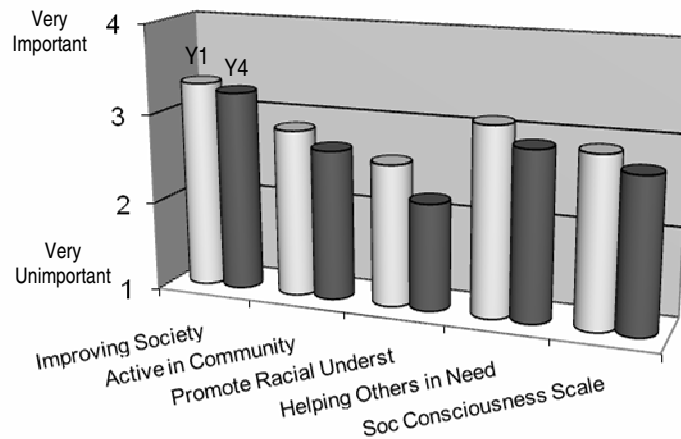


Table 2 presents results from a series of OLS regression models ran with the ethical engagement scale as an independent variable and the public engagement and social consciousness measures as dependent variables. (For example, the fourth model predicts “Personal Importance: Improving Society” using the ethical engagement scale and controls as dependent variables.)

The first column provides the value and significance of the ethical engagement coefficient in the model, and the final column gives the adjusted r-squared and significance of the model itself.

Table 2: Programmatic Emphasis on Ethical Engagement (IV) Predicting Public Engagement and Social Consciousness Values (DVs) in Year 3/Year 4

OLS Models Run with <i>Program Emphasis: Ethical Engagement</i> (and controls)¹ for the following DVs:	Beta and Sig. of <i>Ethical Engagement</i> in Model	Adjusted R2 and model significance
Models for Y3/Y4 measures of Public Engagement and Social Consciousness (DV's)		
Successful Career: Professional/Ethical Responsibilities	.167+	.106***
Successful Career: Understanding the Consequences of Tech	.213*	.094**
Successful Career: Understanding How People Use Machines	.156	.035+
Personal Importance: Improving Society	.415***	.116***
Personal Importance: Being Active in Community	.362***	.107***
Personal Importance: Helping to Promote Racial Understanding	.382***	.129***
Personal Importance: Helping Others in Need	.303**	.091**
Models for Y3/Y4 Scale Measures of Public Engagement and Social Consciousness (DV's)		
Public Engagement Scale	.249**	.148***
Social Consciousness Scale	.464***	.175***

¹Dichotomous indicators for female, Olin, Smith, and UMass were included in each model as controls.

Note: * p<.05 **p<.01 ***p<.001

Table 2 confirms that a programmatic emphasis on ethical engagement is a significant predictor of both public engagement views and social consciousness. The ethical engagement emphasis of students' programs in year 1 significantly and positively predicts how important students consider understanding the consequences of technology in year 3, and how personally important they consider improving society, being active in their community, promoting racial understanding, and helping others in need in year 4. The ethical engagement emphasis of their program also significantly predicts both the scale measures for public engagement (in year 3) and social consciousness (in year 4).

These findings illustrate that students are being affected by the professional socialization processes of their engineering programs. Table 2 shows that the relationships between program emphasis and both social consciousness and public engagement is positive, meaning that if programmatic emphasis on ethical engagement in year 1 is low, social consciousness and public engagement scores will be low in year 3. If students perceive a lack of emphasis on ethical engagement in year 1, they are less interested in public engagement and show less social consciousness in later years. Of course, if the programmatic emphasis scores were high, this suggests that students' later social consciousness and public engagement scores would be higher as well.

A powerful effect of programmatic emphasis might be expected on students' perceptions of a successful career, but the extent to which program emphasis on ethical engagement predicts their *personal* values is surprising. Students are learning the characteristics that are defined as necessary in order for one to be a successful engineer, but even more than that, they are *becoming* engineers in what they value and believe.

Though Table 2 presents clear relationships between the ethical engagement emphasis of engineering programs and the value of respondents' public engagement views and social consciousness in year 3 or 4, we need to understand how the programmatic emphasis is causally related to the *change in* these measures.

Table 3 uses the ethical engagement scale to predict the changes in each of the public engagement and social consciousness measures. The ethical engagement coefficient is positive and significant if the program emphasis has a direct effect on the changes in these values. Since the mean delta scores are negative in Table 1, positive ethical engagement coefficients in Table 3 indicate that *the engineering programs' lack of emphasis on ethical engagement has a direct effect on lowering respondents' public engagement values and social consciousness over time.*

Changes in both the social consciousness and public engagement scale variables are significantly predicted by the ethical engagement emphasis of the program. Students' decreasing beliefs in the importance of understanding the consequences of technology are causally related to their program's lack of emphasis on ethical engagement, as is the decrease in the importance to them of improving society, being active in their community, and promoting racial understanding. In short, students' professional socialization experiences, and the lack of emphasis on ethical engagement, directly dampen students' social consciousness and their interest in a socially engaged career.

Table 3: Programmatic Emphasis on Ethical Engagement (IV) Predicting the Changes in Public Engagement and Social Consciousness Values (DVs)

OLS Models Run with <i>Program Emphasis: Ethical Engagement (and controls)</i>¹ for the following DVs:	Beta and Sig. of <i>Ethical Engagement in Model</i>	Adjusted R2 and model significance
DVs: DELTA measures of Public Engagement and Social Consciousness (Y3 – Y1) or (Y4- Y1)		
Successful Career: Δ Professional/Ethical Responsibilities	-.146	.000
Successful Career: Δ Understanding the Consequences of Tech	.229*	.004
Successful Career: Δ Understanding How People Use Machines	-.019	.000
Personal Importance: Δ Improving Society	.244**	.035*
Personal Importance: Δ Being Active in Community	.188*	.017
Personal Importance: Δ Helping to Promote Racial Understanding	.193*	.003
Personal Importance: Δ Helping Others in Need	.165	.025+
DVs: DELTA Scale Measures of Public Engagement and Social Consciousness		
Δ Public Engagement Scale (Y3 – Y1)	.176*	.044*
Δ Social Consciousness Scale (Y4 – Y1)	.221**	.056**

¹Dichotomous indicators for female, Olin, Smith, and UMass were included in each model as controls.
 Note: * p<.05 **p<.01 ***p<.001

Not all students meet this effect without resistance, however. Table 4 presents the effects of the *changes in* students' perceptions of their programs' emphasis on ethical engagement (the ethical engagement delta scores) on their public engagement and social consciousness measures. A change in respondents' perceptions of their program's emphasis on ethical engagement is

negatively related to the importance to them of improving society, of promoting racial understanding, and of helping those in need. If students recognize their program’s lack of emphasis on ethical engagement over time, they are likely to have higher-than-average social consciousness scores. This highlights students’ potential resistance to the programmatic emphases in which they are being socialized. This resistance may allow them to maintain the high levels of social consciousness they had when they entered college. However, it may also translate into their attrition from the engineering profession altogether once their training is complete.

Table 4: Changes in Programmatic Emphasis on Ethical Engagement (IV) Predicting Public Engagement and Social Consciousness Values (DVs) in Year 3/Year 4

OLS Models Run with Δ Program Emphasis: Ethical Engagement (and controls)¹ for the following DVs:	Beta and Sig. of Δ Ethical Engagement in Model	Adjusted R2 and model sig.
DVs: Y3/Y4 measures of Public Engagement and Social Consciousness		
Successful Career: Professional/Ethical Responsibilities	.154	.108**
Successful Career: Understanding the Consequences of Tech	-.034	.069*
Successful Career: Understanding How People Use Machines	.042	.016
Personal Importance: Improving Society	-.328**	.094**
Personal Importance: Being Active in Community	-.176	.116**
Personal Importance: Helping to Promote Racial Understanding	-.241*	.127**
Personal Importance: Helping Others in Need	-.300*	.140***
DVs: Y3/Y4 Scale Measures of Public Engagement and Social Consciousness		
Public Engagement Scale	.076	.123**
Social Consciousness Scale	-.298*	.144***

¹Dichotomous indicators for female, Olin, Smith, and UMass were included in each model as controls.
 Note: * p<.05 **p<.01 ***p<.001

IV. Conclusion

The purpose of this project was to examine whether and to what extent engineering students’ professional socialization increases their social consciousness and their interest in a career which engages with concerns of public welfare. In an era when the work of engineers spans great, complex technological systems that reach into nearly every corner of modern life, the engineering students in this sample emerge from their engineering programs *less interested* in their ethical responsibilities, in understanding the effects of those systems on society, and in understanding the challenges people face when interacting with these systems.

The results of this study are troubling, given the broad importance afforded to the teaching of ethical engineering practice in the last decades. I find that, among a diverse collection of institutions, programs lack an emphasis on ethical engagement, relative to technical and theoretical issues, and this lack of emphasis is directly related to students’ decreasing social consciousness and decreasing belief in the importance of public engagement in a successful career.

Engineering education is a time when neophytes are most idealistic about the possibilities of their work as professionals and most receptive to the codes of professional ethics that are supposed to influence their work.¹ If they are already disengaged from these interests at this point of supposed idealism, it is likely they will not regain interest in engagement as they encounter the complex realities of day-to-day engineering work.

This lack of public engagement and social consciousness may be endemic in US engineering practice in general. Unlike French engineers, who are deeply entrenched in French bureaucratic life, and German engineers, who participate avidly in public debates about the long-term societal impact of the technologies they create,²⁸ the role of American engineering can fade into economic relations and is often absent in non-technical social debates.^{29,30} Engineers—a population which understands the technical underpinnings of these systems in a deep way—often disengage from considerations of the social impacts of these technologies and from public debates and policy formation about the role of technological systems in society. The profession has often been criticized for being particularly disinterested in social issues.^{31,32,33,34}

There is a silver lining to the results documented here, however. I find that professional socialization is highly effective in influencing both what students consider important in a successful career and the things they find personally important. The ways that engineering programs (and the intuitional and regulatory forces in which these programs are embedded) construct notions of valuable and successful engineering practice and define the characteristics of competent engineers strongly influences how students enrolled in these programs understand their future careers. At the very least, these results illustrate that professional socialization processes work in engineering similar to the ways they have been documented to work in other professions. More importantly, however, this suggests that if engineering programs can overcome the overwhelming institutional, cultural, and regulatory forces that drive isomorphism within engineering education programs, it appears that engineering programs *could* produce a new brand of engineer, one that thinks critically about the social impacts of the technological systems on which she or he works.

Endnotes

ⁱ This material is based upon research supported by a grant from the UC Labor and Employment Research Fund (reference # 07-T-LERF-06-0086). Data on which this work relies were collected for a project funded by the National Science Foundation (grant # 0503351). Any opinions, findings, and conclusions, or any recommendations expressed in this material are those of the author and do not necessarily reflect the opinions of the UC Labor and Employment Research Fund or the National Science Foundation. I thank Heidi Sherick for her valuable feedback on previous drafts.

ⁱⁱ I am not advocating here for the return of 1920s-era technocracy or social engineering.^{28, 34, 35} By “engagement” I mean only the obligations engineers have adhere to their current responsibilities to the safety, health, and welfare of the public, not an expansion of those obligations to non-engineering sectors of society.

ⁱⁱⁱ This study is part of a larger project called “FuturePaths: Developing Diverse Leadership for Engineering,” funded by the National Science Foundation. The present analysis draws from the four years of survey data (2003-2007). All students from the 2003 incoming cohort at each school were invited to participate, but this paper only examines those who started and remained in engineering.

References

1. Becker, Howard, Anselm Strauss, Everett Hughes, and Blanche Greer. 1961. *Boys in White: Student Culture in Medical School*. Chicago: University of Chicago Press.
2. Friedson, Eliot. 1971. *The Professions and their Prospects*. Beverly Hills: Sage.
3. Gravander, Jerry W. 1980. "The Origin and Implications of Engineers' Obligations to the Public Welfare." *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association* 1980:443-455.
4. Larson, Magali Sarfatti. 1977. *The Rise of Professionalism: A Sociological Analysis*. Berkeley: University of California Press.
5. Perrucci, Robert. 1971. "Engineering: Professional Servant of Power." in *The Professions and their Prospects*, edited by E. Friedson. Beverly Hills: Sage.
6. Abbott, Andrew. 1983. "Professional Ethics." *American Journal of Sociology* 88:855-885.
7. Engineers' Council for Professional Development. 1980. "Code of Ethics for Engineers."
8. ASEE emphasis on Ethic and ethics education
9. National Academy of Engineering. 2004. *The Engineer of 2020: Visions of Engineering in the New Century*: National Academies Press.
10. ABET. 1997. *Engineering Criteria 2000 (EC2000)*. <http://www.abet.org/history.shtml>
11. Association of American Colleges and Universities. 2009. *Core Commitments: Educating Students for Personal and Social Responsibility*. www.aacu.org/core_commitments/index.cfm
12. Freidson, Eliot. 1986. *Professional powers: A study of the institutionalization of formal knowledge*. Chicago: University of Chicago Press.
13. Schleef, Debra J. 2006. *Managing elites: professional socialization in law and business schools*. Oxford, UK: Rowan & Littlefield Publishers, Inc.
14. Sullivan, William M., Anne Colby, Judith Welch Wegner, Lloyd Bond, and Lee S. Schulman. 2007. *Educating Lawyers: Preparation for the Profession of Law*. San Francisco, Ca: John Wiley & Sons, Inc. Pp. 13-14
15. Hughes, Everett C. 1971. *The Sociological Eye: Selected Papers on Work, Self, and the Study of Society*. Chicago: Aldine-Atherton.
16. Dryburgh, Heather. 1999a. "Work Hard, Play Hard: Women and Professionalization in Engineering--Adapting to the Culture." *Gender & Society* 13:664-682.
17. Goffman, Erving. 1959. *The Presentation of Self in Everyday Life*. New York: Random House.
18. Barley, Stephen R. and Pamela S. Tolbert. 1997. "Institutionalization and Structuration: Studying the Links between Action and Institution." *Organization Studies*. Vol 18. Pp. 25
19. Granfield, Robert. 1992. *Making Elite Lawyers: Visions of Law at Harvard and Beyond*. New York: Routledge.
20. Greenwood, Earnest. 1966. "The Elements of Professionalization." in *Professionalization*, edited by H. M. Vollmer and D. L. Mills. Englewood Cliffs, NJ: Prentice Hall.
21. Porcello, Thomas. 2004. "Speaking of Sound: Language and the Professionalization of Sound-Recording Engineers." *Social Studies of Science* 34.
22. Hughes, Everett C. 1967. "Professions." Pp. 1-14 in *The Professions in America*, edited by K. S. Lynn: Beacon Press.

23. Ritzer, George. 1971. "Professionalism and the Individual." in *The Professions and their Prospects*, edited by E. Friedson. Beverly Hills: Sage.
24. Zimmerman, Andrew D. 1995. "Toward a More Democratic Ethic of Technological Governance." *Science, Technology, & Human Values* 20:86-107.
25. Seron, Carroll and Susan Silbey. 2009. "The Dialectic Between Expertise Knowledge and Professional Discretion: Accreditation, Social Control and the Limits of Instrumental Logic." *Engineering Studies*. Vol 1 (2).
26. Jackman, Mary R. and Michael J. Muha. 1984. "Education and Intergroup Attitudes: Moral Enlightenment, Superficial Democratic Commitment, or Ideological Refinement." *American Sociological Review*.49.
27. Kane, Emily W. and Elise K. Kyyro. 2001. "For Whom Does Education Enlighten? Race, Gender, Education, and Beliefs about Social Inequality." *Gender and Society*. 15.
28. Downey, Gary Lee and Juan C. Lucena. 2004. "Knowledge and Professional Identity in Engineering: Code-Switching and the Metrics of Progress." *History and Technology* 20.
29. Layton, Edwin T., Jr. 1971. *The Revolt of the Engineers: Social Responsibility and the American Engineering Profession*. Cleveland: Western Reserve Press.
30. Meiksins, Peter. 1988. "The "Revolt of the Engineers" Reconsidered." *Technology and Culture* 29:219-246.
31. Faulkner, Wendy. 2007. "Nuts and Bolts and People: Gender Troubled Engineering Identities." *Social Studies of Science* 37:331-356.
32. Florman, Samuel C. 1994. *The Existential Pleasures of Engineering*, vol. 2. New York: St. Martin's Griffin.
33. Nye, David E. 1994. *American Technological Sublime*. Cambridge, MA: The MIT Press.
34. Nye, David E. 2006. *Technology Matters: Questions to Live With*. Cambridge, Massachusetts: The MIT Press.
35. Jordan, John M. 1994. *Machine-Age Ideology: Social Engineering and American Liberalism, 1911-1939*. Chapel Hill: The University of North Carolina Press.
36. Winner, Langdon. 1977. *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*: MIT Press.