Ethnography in Engineering Ethics Education: A Pedagogy for Transformational Listening

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Miss Erin Heaney, Clean Air: Organizing for Health and Justice

Erin Heaney has led the Clean Air Coalition of Western New York (CACWNY) since 2009. She ran the grassroots campaign against Tonawanda Coke Corporation (TCC) that resulted in a raid of the plant, the federal indictment of the company's environmental control manager, a consent order with the US Environmental Protection Agency (EPA), and the reduction of benzene emissions by 86% in the Town of Tonawanda. Since then, the CACWNY has expanded to organize in several marginalized, Western New York neighborhoods around environmental health and justice issues.

Mr. Glenn Andrew Ratajczak, Clean Air Coalition of Western New York

Glenn Ratajczak is a lifelong resident of the Town of Tonawanda. He was a founding board member of the Clean Air Coalition of Western New York (CACWNY) and has served as the organization's Vice President. Currently, Glenn is a member of the Clean Air Coalition's "Air Tech Team," which provides scientific support to the organization. He is employed in the heart of Tonawanda's industrial center as Crew Chief of the Erie County Water Authority (ECWA) water treatment plant. Glenn is also a part-time student at the University at Buffalo where he is a senior in the Civil Engineering Department. Glenn was awarded the "Unsung Hero Award" from the CACWNY in 2012.

Mrs. Jennifer Holly Ratajczak, Clean Air Coalition of Western New York

Jennifer Ratajczak is a lifelong resident of the Town of Tonawanda. In 2006, at the age of 40, she was unexpectedly diagnosed with Chronic Myelogenous Leukemia (CML), a manageable but incurable cancer. After learning that her disease was likely to be environmentally triggered by benzene exposure, Jen began a quest to find the source of the contamination. Her journey confirmed extraordinarily high levels of benzene in Tonawanda's air and led Jen to dedicate her life's work to the health and wellbeing of the people of Tonawanda. Jen served as a founding board member of the Clean Air Coalition of Western New York (CACWNY). Jen was the first recipient of the organization's "Unsung Hero Award" in 2010.

She currently remains an active member of the CACWNY and serves as an advocate for the Leukemia & Lymphoma Society of Western New York. Jen also serves as Chair of the Re-Tree Tonawanda program. Jen holds an MS in Multidisciplinary Studies from Buffalo State College with a concentration in the management of adult learning and development.

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Abstract

In engineering, listening is increasingly embraced as an essential professional skill. Listening instruction in engineering education, however, is rare. This paper proposes that listening to the diverse voices of publics affected by engineering decisions, discoveries, and products is crucial for ethical practice. It contends that listening can facilitate transformational engagement between engineers and the public by a) challenging stereotypes on both sides, b) foregrounding the technical and ethical relevance of diverse knowledges, c) exposing relationships of structural inequality that privilege technical expertise, and d) replacing such relationships with partnerships of trust that generate meaningful and effective solutions.

Transformational listening lies at the heart of a graduate engineering ethics course at Virginia Tech and future online teaching modules, funded by the National Science Foundation (NSF). The goal is for students to experience the cognitive leap that ethnographic research methods can facilitate – moving from a stance of ignorance, confusion, and even outright disagreement concerning an unfamiliar position, to a stance of clarity and even appreciation for reasoning that can underlie marginalized or misunderstood perspectives. To illustrate the method, the paper focuses on a partnership between the class and a grassroots environmental health and justice organization in Buffalo, NY. This partnership was designed with two objectives: a) to support students to elicit and understand the knowledge, experiences, and goals of community members fighting a highly publicized case of environmental contamination; and b) to equip students to recognize the imbalances of power often entrenched in such cases. The goal was to teach students skills for grounding moral dilemmas in their social contexts, and for engaging in ethical reasoning that is informed by the values locally at stake. Strengths and limitations of the approach are explored through six lenses: that of the course co-instructor, two graduate students, and the director and two founding members of the partner organization. In closing, the paper discusses the potential of this pedagogy to help transform the relationship between engineers and the public by supporting morally engaged 21st century engineering practice.

Introduction

When students in Virginia Tech's Fall 2013 graduate-level class "Engineering Ethics and the Public" were asked what "voices" their education trains them to listen to, they answered: those of their professors and other "community elders" (e.g., renowned leaders in science and engineering), and rules and regulations guiding their respective fields of expertise. The same group of students stated that their education encourages them to pay practically no attention to voices of non-experts. This demarcation of what, from an engineering standpoint, counts as legitimate knowledge and what does not, suggested a technocentric worldview that positions dominant technical understandings, practices, and priorities above all other points of view. Numerous studies of engineering

education and the engineering profession at large discuss technocentrism in engineering as a systemic and problematic phenomenon that demands critical examination.[1,2,3] They contend that inability to recognize the value of perspectives different from conventional points of view limits engineers' capacity to develop locally appropriate and sustainable technologies;[4,5,6] assess and effectively communicate risk;[7,8] address or prevent social injustices that may result from engineering research, products, practices, or decisions;[9] forge productive international and intercultural collaborations;[10] and democratize technical knowledge-making.[11,12] A frequently proposed solution is the incorporation into engineering curricula of training that instills in engineering students the ability to listen to, understand, and take into serious consideration diverse stakeholder perspectives.[4,13,14,15]

Increasingly, listening in engineering is promoted as an essential professional skill not only by individual scholars and practitioners, but also by engineering organizations. The US National Academy of Engineering (NAE) states that its vision for the engineer of the 21st century includes the ability to engage multiple stakeholders (i.e., governments, industry, and the public) nationally and internationally through "good communication." "We envision a world," says the NAE, "where communication is enabled by an ability to listen effectively as well as to communicate through oral, written, and visual mechanisms."[16] The American Society of Civil Engineers (ASCE) also considers listening a key element of good communication. In its own vision of 21st century civil engineering, it states: "Means of communication include listening, observing, reading, speaking, writing, and graphics. The civil engineer must communicate effectively with technical and nontechnical individuals and audiences in a variety of settings. Use of these means of communication by civil engineers requires an understanding of communication within professional practice. Fundamentals of communication should be acquired during formal education."[17]

In practice, however, training in listening is rarely included in the engineering classroom.[13] In fact, counter to the engineering profession's ideal of engagement, it has been suggested that engineering education fosters a "culture of disengagement." According to sociologist Erin A. Cech, this culture is based on three ideological pillars: an ideology of depoliticization, which presumes that the work of engineers can and must take place in a sociopolitical vacuum; a technical/social dualism that deems concern about the impact of engineering on society as secondary to technical competence; and a belief in the robustness of meritocracy, which is based on the idea that existing institutions and institutional processes are fair and just and that, as a result, do not require the engineering profession's attention or intervention.[18]

The engineer's separation from society, although not explicitly promoted, seems to underlie key official messages about the engineering profession as well. For example, the Accreditation Board for Engineering and Technology (ABET) criteria include 11 student outcomes that, even when not strictly technical, are presented as if the training necessary for achieving them can be obtained fully in the classroom. One such outcome is the "ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health

and safety, manufacturability, and sustainability." Another is the "ability to identify, formulate, and solve engineering problems." A third is "knowledge of contemporary issues."[19] By not specifying *whose* definitions of "desired needs," "realistic constraints," "engineering problems," or "contemporary issues" are to be used and *how* these definitions are to be identified, ABET seems to imply that somehow students on their own *can know* the technical and social complexities associated with their work simply by virtue of their training. At the same time, student ability to elicit and take into account non-dominant perspectives is absent from the list.

Similarly technocentric is the NAE's widely disseminated and highly influential 2008 report *Grand Challenges for Engineering*. *Grand Challenges* features 14 areas for future engineering research that a committee of engineers and scientists deemed "achievable," "sustainable," and capable of helping "people and the planet thrive."[20] As discussed in numerous critiques, however, the choice of selected challenges is narrowly technological; reflects some of the committee members' own research or institutional interests; and places little emphasis on simple, low-tech solutions and problems of equity and social justice.[21,22,23] Moreover, it does not seem to represent "people's" own views on what engineering challenges compromise their ability to "thrive" and how engineers can help address these challenges.

In her discussion of the *Grand Challenges*, Cech aptly evokes the "god trick," a term coined by science and technology studies scholar Donna Haraway.[11] The "god trick" refers to the mythic ability of officially sanctioned technical experts to see "everything from nowhere" – that is, from a position of complete distance from the social world and thus with supposed über-objectivity.[24] Whether this position is claimed with idealistic or self-serving intentions, it is often accompanied by the belief that unfamiliar observations, experiences, needs, goals, and knowledge claims are not only irrelevant but also an obstacle to "good engineering." Yet starting in the 1970s, a large number of cases involving health social movements and environmental justice activism have demonstrated that "scientific counterpublics"[25] (i.e., networks of scientists and non-scientists that contest dominant discourses, practices, and knowledge claims) can often complement, complete, expand, and even correct previously unquestioned expert perspectives.[e.g.,26,27,28,29,30] These cases demonstrate that failure to listen to unconventional voices leaves engineers vulnerable to incomplete understandings of complex issues, self-interest, self-delusion, and personal and institutional pressures that can contribute to suboptimal professional decisions and unethical conduct, as well as the causation, prolongation, or exacerbation of social injustices and public harm.[31] In this paper, we argue that listening limits engineers' capacity to practice not only effectively, but also in a morally engaged manner.

Toward an empirical engineering ethics education

The public's wellbeing constitutes not only the primary ethical obligation of engineers, but also the foundational principle of the modern engineering profession. The first "fundamental canon" of the engineering code of ethics is that practitioners "shall hold

paramount the safety, health and welfare of the public in the performance of their professional duties."[32] Concomitant guidelines further specify that,

> Should the Engineers' professional judgment be overruled under circumstances where the safety, health, and welfare of the public are endangered, the Engineers shall inform their clients or employers of the possible consequences and notify other proper authority of the situation, as may be appropriate.[33]

The imperative that engineering students develop a solid grasp of their duties toward society is formalized in ABET's required student outcomes. One of these outcomes demands demonstration of "an understanding of professional and ethical responsibility," while another necessitates acquisition of "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."[19] Once again, the implication seems to be that moral responsibilities are fixed and pre-determined and that assessments of the societal impacts of the engineer's work can be achieved from a "god trick" position of isolation.

Nowhere do engineering codes of ethics require practitioners to keep refining their definition of their moral obligations in response to public voices about specific engineering research, products, practices, and decisions; nor do they require consideration of local or counterpublic perspectives on the "costs" and "benefits" of specific engineering interventions or on quality-of-life priorities, concerns, needs, and goals. The "good engineer," it seems, is bred for "moral superheroism." Not only is he/she equipped to define on behalf of the public subjective values like public "safety," "health," and "welfare," he/she is also able to assess the "best" technological paths to achieve these values. As English scholar Julia M. Williams observes, a close examination of engineering codes of ethics suggests a presumption that engineers can and must serve as "technological stewards." Williams argues that it is not a "big leap" to turn expectations of technological stewardship into a "technological paternalism, an 'engineer knows best' perspective that puts the engineer at odds with society."[34] Exacerbating concerns about the appropriateness of the moral authority that is granted to engineers by their own profession, is Cech's recent finding that the "culture of disengagement" in engineering education is actually failing at fostering in students a sense of commitment to the public good.[18]

Technical training grants engineers tools to build knowledge about aspects of the world that are largely invisible to the public. This monopoly on the "truth" about the physical environment places engineers in a position of significant professional power.[35] Engineering discoveries, often trusted as reliable, give form to societal understandings about not only what is "real" but also what is technologically "possible," "feasible," and "best." They also shape public policy and personal behaviors. As a result, the engineer's knowledge claims can have far-reaching implications.

Defining engineering ethics as at least in part about the use and misuse of professional power, we contend that ethical practice requires engineers to possess skills not typically taught in engineering programs. These skills allow for "ethical contextualism" – that is, the grounding of moral dilemmas in their social contexts through consideration of

diverse stakeholder perspectives, as articulated by stakeholders themselves (e.g., publics, counterpublics, governments, industries). Social science research has demonstrated that stakeholder voices can reveal significant perspectives that are often overlooked in traditional renditions of ethics cases.[e.g.,36,37,38,39,40,41,42] By extension, they can facilitate better-informed data-gathering and analysis, and more robust moral judgments. The benefits of contextualizing ethical dilemmas were vigorously promoted by medical ethics researchers in the mid-1980s. Underlying this movement was ethnographic work showing that morality is not a fixed, abstract construction existing independently from day-to-day living and practice, and thus it ought not be employed outside the real-world contexts of ethical dilemmas.[43,44,45] Renowned bioethicists argued that empirical ethics "can raise questions about the universalizability of normative claims" and "can identify areas of disagreement that are ripe for ethical inquiry."[46] Indeed, the use of empirical methods to examine ethical dilemmas in clinical medicine is credited for helping bioethics evolve into a multidisciplinary field that, some have argued, has finally realized its "full potential."[41]

Empirical social science research methodologies, such as ethnography, participant-observation, focus groups, semi-structured interviews, and qualitative surveys to examine ethical dilemmas at the intersection of biomedicine and society can be equally useful for the examination of ethical dilemmas at the intersection of engineering, science, and society. A good example is the multidisciplinary study by engineer Donna Riley, demographer C. Alison Newby, and Santero Tomás O. Leal-Almeraz of traditional practices involving the use of mercury in Latino and Caribbean communities.[47] Ethnographic interviews and participant observation enabled the researchers to a) assess potential health risk and b) develop risk communication and public policy recommendations that took into account *how* the communities in question actually used mercury and *what* they believed about it. This research revealed that contrary to prevailing stereotypes, highest-risk uses of mercury were not associated with Santeria religious rituals. Moreover, criminalization of the incorporation of mercury into traditional Latino and Caribbean practices was far less likely to prevent hazardous exposures than respectful and non-threatening risk communication.

If the main moral obligation of the engineer is to better the condition of humankind by solving societal problems,[48] then an empirical approach to engineering ethics education can offer students important insights into *how* society defines its problems and *what* engineering solutions it desires. As political philosopher Langdon Winner asserts, "Ethical responsibility now involves more than leading a decent, honest, truthful life, as important as such lives certainly remain. …Our moral obligations must now include a willingness to engage others in the difficult work of defining the critical choices that confront technological society and how to confront them intelligently."[49] Absent of such engagement, it can be argued that ethics education may inadvertently function as a fourth ideological pillar in the "culture of disengagement," and "ethical reasoning" may unwittingly result in unethical professional practice.

A pedagogy for transformational listening

Echoing calls by an increasing number of engineers, social scientists, members of health social movements, and environmental justice activists, we propose that the engineering profession will strengthen its ability to "hold paramount the safety, health and welfare of the public"[32] by replacing the "moral superhero" conception of the "good engineer" with an expanded but more humble vision.[50,51] It is time to begin training students to see themselves not as "definers" and "solvers" of society's problems, but as society's technical experts who have the moral duty to *partner* with professionals and non-professionals alike in order to help identify problems and develop solutions that are truly "achievable," "sustainable," and capable of helping "people and the planet thrive."[20] In this alternative vision, listening is an imperative.

Listening is viewed as essential to the improvement of professional services in several fields. In public health, the increasingly popular research model "community-based participatory research" (CBPR) – which "calls for equitable and collaborative involvement of community members and researchers in all aspects of research"[52] – is based on listening.[53,54,55] In medicine, the growing movement to incorporate humanities into medical school curricula has stemmed from the recognition that to be more effective, doctors must learn to "truly listen" to their patients.[56,57] Toward this end, Yale and Stanford universities commissioned actress, playwright, and MacArthur Fellow Anna Deavere Smith to conduct classes in "listening" in order to teach doctors "how better to hear what patients are saying."[58] Smith delivers her message through impersonations of patients she studied by listening, herself, to their stories.[59,60] Smith explains that "excursions" into people's lives through listening can reveal "*other* ways of thinking about the things that are right and wrong about us" (emphasis in original).[61] In their book *Stories Matter: The Role of Narrative in Medical Ethics*, Narrative Medicine scholars Rita Charon and Martha Montello explain:

> The practice of narrative ethics has developed organically, over the past two decades or so, germinating throughout North America, the United Kingdom, Europe, and parts of Asia, suggesting that this approach to ethics has answered a widespread need within the field. Not a top-down activity, narrative ethics emerged from individuals' ethics practices as they, often on their own, found themselves listening in new ways to their patients and thinking in new ways about cases. […] Various intellectual disciplines in the past two decades have taken the so-called narrativist turn: recognizing the extent to which perceptions are embedded in their telling, realizing human beings' reliance on storytelling to get their bearings in life, and acknowledging the innately narrative structure of human knowledge and provisional truth. Historians, cognitive psychologists, social scientists, theologians, psychiatrists, and literary critics have come to recognize the central role that narrative plays in the way we construct knowledge, interpret experience, and define the right and the good.[62]

In engineering, listening to unfamiliar voices can uncover "*what is locally at stake*" (emphasis in original).[63] Listening lies at the heart of Virginia Tech's "Engineering Ethics and the Public," a graduate-level elective class, co-conceived and co-taught by civil engineer Marc Edwards and medical ethnographer Yanna Lambrinidou. The goal is for students to use ethnographic listening – i.e., listening that elicits a stakeholder's worldview in detail and that is free of listener inference or interpretation – in order to experience the cognitive leap that allows movement from a stance of ignorance,

confusion, and even outright disagreement with an unfamiliar position, to a stance of clarity and even appreciation for diverse experiences, knowledges, and reasoning that can underlie marginalized or misunderstood perspectives. Perhaps more importantly, listening is used as a vehicle for understanding how potentially unconventional views can complement, complete, expand, or even correct dominant engineering perspectives.

"Engineering Ethics and the Public" is divided into four thematic units: a) responsible conduct of research, b) responsible conduct of practice, c) witnessing wrongdoing and the obligation to prevent harm, and d) learning to listen. Each unit is explored through the study of professional codes of conduct; moral theory; and multidisciplinary writings at the intersection of ethics, engineering, science, and society. Drawing on insights about the value of teaching ethics through "emotionally rich" real-world cases,[64] the course ties all thematic units together with a semester-long presentation of one case: the Washington, DC lead-in-water crisis of 2001-2004 – a highly publicized, multi-dimensional, and still-unfolding event of environmental contamination in which both course instructors have been involved, and which they have studied extensively for a decade. The case is examined through primary government documents; peer-reviewed studies; newspaper, legal, Congressional, and other reports; as well as the voices of multiple stakeholders – parents, pediatricians, journalists, engineers, scientist whistleblowers, and clean water advocates, among others – involved in the case. Student assignments include:

- Two renditions of a "Story of Self," one written at the beginning of the semester and one at the end: Inspired by the leadership-training tool of Harvard University professor Marshall Ganz,[65] this exercise asks students to write a narrative about who they are, what their history is, what values they see as guiding forces in their lives, what compelled them to pursue graduate studies, and what their larger professional purpose is. The intent of the exercise is to encourage deep and ongoing reflection on one's identity and moral aspirations outside the boundaries of conventional measures (e.g., academic achievements, job successes, awards) and *in relation to* "publics" that may be – at that time or in the future – affected by the student's work.

- Three exercises on ethnographic listening: The first two are designed as preparation for the third. The intent of the exercises is to support students in developing tools to listen closely to unfamiliar points of view without automatically collapsing new information into familiar categories. This approach to listening allows for, in Piagetian terms, "accommodation" of new ideas (i.e., modification of existing cognitive categories or creation of new ones to make room for information that does not fit into preexisting schemas) rather than "assimilation" (i.e., insertion of new information into preexisting cognitive categories, even if this requires altering or ignoring parts of the information that do not quite "fit").[66]

    1. Exercise 1 – "Anatomy of In-Depth Listening": Students are asked to reflect on their own experiences of in-depth listening, in personal or

professional encounters. They are to focus on four events: a) a time when they felt *really* listened to, b) a time when they remember *really* listening to someone else, c) a time when they felt *really not* listened to, and d) a time when they remember *really not* listening to someone else. Students are asked to describe behaviors, observations, and feelings that accompanied these interactions. Responses are compiled for everyone's review. They offer insights not only into what "good" (or "bad") listening looks and feels like from the perspective of speaker and listener alike, but also into what interpersonal impact such listening may have. For example, student responses have revealed that when speakers feel listened to, they often experience greater self-confidence and clarity of thought, whereas when they feel not listened to, they begin to lose their train of thought, become inarticulate, and deem what they are saying as insignificant. These insights expose for students the power they can have as listeners, especially when in the role of technical expert.

2. Exercise 2 – "Practice of In-Depth Listening": Students are asked to conduct one face-to-face interview with someone they know (e.g., friend or relative). Their questions are to focus on understanding views (or behaviors) that their interviewee holds (or engages in) and that the students find strange or outright wrong (e.g., a dietary practice, hobby, health-related practice, political or religious conviction, controversial position on a dispute). The goal of the interview is to gain complete clarity on the interviewee's views/behaviors and reasons behind his/her worldview. Students are advised to ask all questions necessary that will enable them to put themselves in their interviewee's shoes and to see the subject in question from their interviewee's perspective. They are reminded that their task is *complete understanding* of their interviewee's perspective, *not necessarily agreement* with it. Written reports about the exercise are expected to provide reflections on what students learned from their interviewees and how they performed as interviewers. The latter assessment is to include interviewee feedback as well. The exercise gives many students their first ever experience conducting an ethnographic interview. A common theme in student reflections is that *really* listening allows one to see the reasoning behind an interviewee's worldview, even if the interviewer continues to disagree with the beliefs or behaviors in question. This cognitive leap often leads students to replace earlier judgments about the interviewee (e.g., he/she is "irrational," "ignorant," "stupid") with an appreciation for values, circumstances, experiences, and information that shape the interviewee's perspective but that were unknown to the student before the interview.

3. Exercise 3 – "In-Depth Listening in Engineering and Science": This exercise, the apex of the training, requires sustained research of an unfolding engineering controversy. It culminates in an ethnographic interview of a public stakeholder whose voice is under- or misrepresented

in official depictions of the case. The assignment can be designed in multiple ways. We have implemented two:

In the first, students identify a current, real-world controversy of interest to them. They conduct extensive background research to familiarize themselves with the case history, main developments, and key stakeholder perspectives. Drawing on professional codes of conduct and moral theory, they determine which individuals/institutions in the case are bound by special obligations to respect established standards of conduct and protect the public good. They also discuss aspects of the case that concern them from a moral standpoint – that is, positions/decision/actions of some stakeholders that seem to place other stakeholders at risk, cause or prolong harm, violate human or legal rights, mislead or deceive, reproduce power imbalances, and/or perpetuate social or environmental injustices. They then identify a stakeholder, individual or grassroots community group, who seems to have limited professional, political, and/or economic power, and whose voice is not captured prominently in official reports of the case. They invite this stakeholder for an interview that is designed to a) elicit his/her perception of the case; definition of the problem and rationale behind his/her position; experiences, knowledge, needs, goals, concerns; opinion about what immediate actions he/she wants to see taken; views on viable and preferable long-term solutions; and experiences with (and expectations of) engineers and scientists in the case; b) help them expand and possibly revise their existing understanding of the case to include any new dimensions they learned about from their interviewee. Final reports consist of a detailed description of the case (i.e., history/background, main stakeholders and professional responsibilities, detailed description of the interviewee's point of view) and a discussion of key moral transgressions, as identified by the interviewee. Reports close with "lessons learned" from interviewees that changed students' original understanding of the case, as well as a reflection on the conduct of engineers/scientists in the case that includes thoughts on actions students would want to take if they, themselves, were involved in the controversy.

In the second, the class partners with a grassroots community group that is a key stakeholder in an unfolding engineering controversy. Students, collectively, conduct extensive background research on the case to familiarize themselves with its history, main developments, and key stakeholder perspectives. Once again, drawing on professional codes of conduct and moral theory, they determine which individuals/institutions in the case are bound by special obligations to respect established standards of conduct and protect the public good. They also discuss aspects of the case that concern them from a moral standpoint. The community group makes one class presentation and gives students the opportunity to ask questions that fill gaps in their research. With the help

of the group, students are then paired up individually with local stakeholders (e.g., members of the organization, journalists, independent scientists, agency representatives) to conduct ethnographic face-to-face, phone- or video-conferencing interviews. The purpose of these interviews is the same as above, although in this case some of the stakeholder interviewees are individuals with professional authority and/or institutional power. Final projects consist of individual in-class presentations and group discussion of the case from diverse stakeholder perspectives, with an emphasis on under- or misrepresented points of view. Presentations close with "lessons learned" from interviewees that changed students' original understanding of the case, as well as reflections on the conduct of engineers/scientists in the case that, as above, include thoughts on actions students, themselves, would want to take if they were professionally involved in the controversy.

This exercise offers students tools to expand their data-gathering expeditions beyond the traditional confines of online sources, and to appreciate the moral significance of paying attention to information that has not (or cannot) make it into the electronic public sphere. Learning outcomes include a) first-hand appreciation of the technical and ethical value of marginalized voices (expert and non-expert alike), b) new understandings of the case from knowledge, data, and experiences excluded from the official record, and c) reassessment of engineering "best practices" from public perspectives.

Application of transformational listening in a community-academic partnership

In the Fall of 2012, our class formed a partnership with the grassroots environmental health and justice organization Clean Air Coalition of Western New York (CACWNY), in Buffalo, NY. The collaboration involved a formal agreement and small fee to cover the cost of the group's work. A summary of the case is offered below. Strengths and limitations of the approach are explored through six lenses: that of the course co-instructor, two graduate students, and the director and two founding members of CACWNY.

Case summary

The Town of Tonawanda is located on the Niagara River just north of Buffalo, NY, with a population of 75,000. Tonawanda is also home to the highest concentration of industrial air-emitting facilities in New York State. Observing increasingly growing instances of serious health issues in the community, in 2004 a group of concerned citizens formed a grassroots organization to address suspicions of a link between Tonawanda's chronic poor air quality and residents' declining health.

The group took it upon themselves to collect air samples in order to detect any measurable toxins. The results indicated the existence of high levels of benzene, a known human carcinogen. In 2005, the group presented their findings to the NY Department of Environmental Conservation (DEC), which responded two years later with the initiation of a formal one-year air quality study. The study confirmed alarmingly high levels of benzene. In 2009, the DEC pinpointed the largest emissions source: Tonawanda Coke Corporation (TCC), a producer of foundry coke. That same year, a comprehensive facility compliance inspection was conducted at TCC by the DEC and the Environmental Protection Agency (EPA). Following this inspection, numerous enforcement actions were issued for violations of the Clean Air Act (CAA), Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA). In addition to these enforcement actions, the United States Attorney's Office executed a raid of the plant, resulting in a 19-count indictment for criminal violations of the CAA and RCRA by TCC and its environmental manager. The company and its manager were found guilty on 14 of the 19 counts against them. As a result of the work of the grassroots group as well as the legal and enforcement actions, benzene levels in Tonawanda today have decreased by 86 percent since the initial DEC study in 2007.

Participant reflections

William Rhoads, Graduate Student, Virginia Tech

The extent of my ethics training while completing my undergraduate degree in Civil Engineering was reading and trying to memorize the "fundamental canons" of the ASCE Code of Ethics in preparation for my "Fundamentals of Engineering" exam. I suppose I operated on the assumption that as long as I am a generally good person, I was not in real danger of making unethical decisions or doing any real harm; but truthfully, the ethics behind my professional decisions was not something about which I had spent time thinking or with which I had any meaningful engagement until I took "Engineering Ethics and the Public."

As a Civil Engineer, I do have the ASCE "fundamental canons" to help guide my professional decisions, but it is apparent that these alone, even when reinforced by good character and intentions, do not cover all day-to-day moral and ethical professional decisions. The in-depth case studies we experienced with the class opened my eyes to this fact and showed me how small, day-to-day decisions can influence future actions. For example, I learned that seemingly minor "slipups" like exaggerating deliverables to meet the expectations of a client or to secure funding or jobs, while perhaps noble in their intent, can be baby steps toward larger ethical wrongdoing; and the more you justify these slipups, the easier it is to make increasingly dubious decisions.

The same case studies taught me that listening to the voices of public stakeholders – even when they have no technical expertise – can at times change how experts view an issue and lead to solutions not thought about before. In engineering

school, we are used to starting off with well-defined problems, characterized by clear givens and unknowns. Early on we are told what method to use to design a solution. As our education progresses, the problems become less well-defined, so to solve them we sometimes have to recognize that information is missing and go and look it up. At that point, we are expected to figure out which method is most appropriate; and in some cases, while there may not be a "best" method, we are expected to justify our choice. One would think that when working on problems involving a community we would be encouraged to consider the community itself as another source of input to help us define the problem's "givens" and arrive at a locally appropriate solution. Yet in practice, our training almost conditions us to ignore non-technical information and discount technical information that does not come from an "accredited" source.

Our in-depth study of the Tonawanda, NY case reinforced the value of non-expert information. It revealed that people in positions of power must resist strong personal and institutional pressures in order to stay open-minded and be able to a) gather all relevant facts and b) make morally sound and effective decisions. One of the most common ways in which engineers and scientists dismiss public stakeholders is by assuming they are misinformed, unreasonable, and in demand of impractical solutions. From my experience with the TCC case and other cases like it, I now know that this assumption is often inaccurate. Listening to the citizens of Tonawanda, it became immediately apparent to me that they held both accurate and very valuable technical information. At the same time, their demands struck me as far from unrealistic.

My one-on-one ethnographic interview with Erin Heaney, the Executive Director of CACWNY, revealed that her group's main goal was to make the community safer to live in. They were trying to achieve this through dialogue with the owner of TCC in the hopes of reaching an agreement on a reduction in the plant's hazardous emissions. This goal departed dramatically from stereotyped portrayals of environmental activists wanting nothing less than to see factories shut down and gain millions of dollars from lawsuits. It was only when the owner declined to participate in a dialogue that the citizens turned to the agencies in charge of monitoring and regulating the plant. Amazingly, they were met with a similar reluctance to interact. As a result, residents began their own air monitoring that revealed levels of benzene in the air exceeding the maximum limit. The community's technical and experiential knowledge moved EPA into action. The agency confirmed the citizens' results and indicted TCC, which eventually led to significantly lower benzene emissions in the air. This change was driven by a small group of untrained, but extremely motivated citizens – a victory for public health that many academic researchers are not able to claim.

In retrospect it seems obvious to me that the task of understanding all the intricate and complicated details of a case like Tonawanda is as demanding as a full-time job. So it seems counterintuitive that engineers are not trained to make use of information collected by concerned and sometimes affected stakeholders who are

at least as committed as experts (if not more) to finding a practical and health-protective solution.

My work on the Tonawanda case reinforced the importance of listening not only to public stakeholders, but also to myself because it demonstrated that ethical dilemmas in engineering are not unique or uncommon, and that setting personal and professional moral boundaries *before* you encounter these dilemmas can help you maintain confidence in your decision-making and avoid early slipups. For the class, I had the opportunity to write (and later re-write) a "statement of self," where I attempted to outline my own personal history and a philosophy of how I want to live my life. Each time I re-read my statement, I feel very proud about writing certain parts, but I still find parts with which I no longer agree and end up revising.

In the end, listening helps you draw moral lines, whether consciously or without concrete realization. And drawing these lines helps you act on your moral convictions. It is clear to me now that being good-natured is only one of many tools you need to aid your decision-making. Listening and reflection are extremely vital as well. Unfortunately, they are institutionally (and personally) undervalued engineering instruments.

Siddhartha Roy, Graduate Student, Virginia Tech

During the four years of my Chemical Engineering undergraduate program, there was a barrage of technical "know-how" and a smorgasbord of activities that exposed us to the industrial sector (e.g., lectures, seminars, site visits, internships). The idea was to get us "up to speed" on the big production facilities Chemical Engineers build – oil and gas, for instance – and how these facilities fulfill the needs of mankind and advance the global economy. There was an emphasis on "soft skills" too – including interpersonal listening – but this was implicitly aimed at grooming us to stand out in interviews and boardrooms from the herd of colleagues who lacked communication skills. Listening was an asset that we were taught to view as a "booster" to our career prospects.

This career orientation model was built around the goal of creating engineers who fulfill what industry demands. Academia itself was seen as an engineer "churning factory." Don't get me wrong. The curricula and our initiation into the industrial sector were top notch. The message we got about our role in society, however, was a blur. Although we had courses with case studies depicting huge engineering failures and their catastrophic consequences (e.g., the Union Carbide Bhopal tragedy), the public side of these cases was highlighted faintly at best. My training included tools that would allow me to assess the technical repercussions of my actions – say, the amount of waste effluent discharged while running a dye manufacturing factory – but not *how* these same actions might impact people's lives or the environment. I saw both environment-friendly and environment-

apathetic facilities, and I accepted both at face value without ever thinking about their impact on society.

I was aware of the medical profession's Hippocratic Oath, but I never knew there was something similar for engineers. My first exposure to the "Fundamental Canons" in engineering codes of ethics came much later, in graduate school. In a nutshell, my undergraduate program trained me to be an industry professional who was "easy to manage." This was also one of the mantras I was given on my first day in IT consulting. Perhaps not surprisingly, prior to taking "Engineering Ethics and the Public," I thought I was supposed to be a professional "chameleon." In fact, I didn't see much wrong with the idea. I am sure there are many people who would endorse such an identity since it gives the world engineers who can serve industry well and even "make it big" for themselves. Today, however, my concern is: in our chameleon-like existences, are we missing a big "big picture" question about *the ethical implications of our work*? Are we risking training scientists and engineers who cannot see beyond their To-Do list of the day and surrender critical thinking to their bosses (or worse, no one)?

The public health concerns of Tonawanda residents were constantly ignored by the TCC, which continued to emit carcinogenic toxins and contributed to serious public health damage. The unrelenting efforts of the community to have their voices heard was what really made a mark on me. Working-class and low-income individuals, some with serious health problems, went to great lengths to amass data that the authorities would actually (eventually) listen to. It quickly became apparent to me that *the public lacks neither smarts nor common sense and can in fact have important information that may be essential to solving challenging engineering puzzles.* It was a revelation to realize that the knowledge required to engineer morally and technically sound and sustainable solutions can, thus, come not only from cutting-edge research and experts but also from affected communities who may not always *know* the science, but can *do* science and provide crucial missing dots.

The academic-community partnership I found myself in afforded me complete immersion into an environmental health controversy and hands-on experience I could not have gotten by analyzing textbook case studies. For the TCC case, I conducted extensive background research, interviewed a community stakeholder, and had the opportunity to meet with individual residents in their living rooms on a subsequent site visit I volunteered to join. Through these experiences, I was able to put a human face to the Tonawanda case, which I think is often missed in more conventional approaches to ethics education. Tonawanda has real cancer victims, families who lost loved ones, and citizen activists who are working feverishly to right the wrongs done to them. Tonawanda has human beings who have a story to tell about who they are, what they value, how they or their loved ones were harmed, what they would like to see done about it, and what kinds of help they would like (and not like) from engineers like myself. I don't think I can emphasize enough the value of citizens showing engineers the mirror. For me this places us

all on a brand new plane, where we are able to begin chipping away at the misguided orthodoxy of technical experts dictating to and directing the public, for the public's "own good."

Listening is our most frequently used and least studied communication skill.[67] Today, because of my conscious efforts to listen to all sides of an engineering controversy, my decision-making has been expanded to include a moral element it did not have before. Without serious consideration of multiple points of view, including of those potentially most affected by my work and least able to influence it, I cannot possibly know how to best apply my knowledge. It now seems clear to me that professional training for engineers should increasingly rely on actual interactions with both experts and affected communities. This would help students appreciate the "big picture," develop an internal moral compass, and work beyond being just another cog in the machine.

In the end, our education should encourage us to challenge the "stories" we tell ourselves about ourselves. Our internal dialogue and life experiences can forge an indelible mental image on our ideas about "who we are" and "what we are capable of." With time, these definitions can become stagnant and, thereby, narrow our imagination about the kind of professionals we can be. Honest self-reflection can transform our professional identities (and trajectories) by giving us the courage to envision ourselves as individuals with moral agency. The difference between my first and consequent "stories of self" is not only fulfilling and empowering, but also representative of the malleability of our self-definitions. Breaking the mold of *Spock* from Star Trek, *Dr. Sheldon Cooper* from the Big Bang Theory, and the countless stereotypes that engineers and scientists are likened to, I would want the modern engineer to be seen in the light of a caregiver – skilled and ethical because engineers work *with* society to enhance society's wellbeing. The public is *our ultimate client* and, hence, tired images of the high-nosed "expert" engineer cut off from the "non-expert" world just won't do.

Glenn and Jennifer Ratajczak, Founding Board Members, CACWNY

The TCC case offers many examples of the potential effects *not listening* can have on a community. After the DEC released the six-month results of their air monitoring study in early 2008, high levels of benzene were confirmed, although at this time there were not enough data to determine the source. Our organization immediately suspected TCC, as they were the largest reported emitter in the area. From our observations and experience, we documented the chronic black emissions streaming from TCC's stack and the pungent odor that carried in the wind for miles. We gained additional invaluable information by talking to people who worked and resided near the plant. We also developed a very important relationship with a former employee of TCC who explained to us the dirty business of a coal processing plant. This individual kept in touch with an active TCC employee who could always explain to us what was going on behind the scenes.

In the spring of 2008, a few members of our organization decided to research TCC's environmental history. A logical starting point was to review the facility's file and Title V air permit, which was maintained by the DEC. Upon arriving at the DEC, we were greeted by the environmental engineer who was and still is overseeing TCC. She asked why we wanted to review the facility's files. She then proceeded to tell us that we would not find anything of interest; TCC did not have any major violations. When we questioned the status of TCC's air permit, which was in the process of renewal, the DEC engineer advised us that the permit was not in need of any changes and it was waiting to be rubber-stamped. With benzene levels so drastically high, we questioned how this air permitting process could be treated like a mere formality and why TCC's permit was not being reexamined. We were again told by both the DEC's environmental engineer and the DEC's regional engineer that TCC was doing nothing wrong.

Our organization continued to gather evidence from community members and TCC informants that contradicted the engineers' assurances. We collected information about TCC's mishandling of tar sludge, the malfunction of equipment, which resulted in coke oven gas being vented directly into the atmosphere, and numerous pictures of dirty emissions. While we struggled to inform the DEC of our knowledge, we were routinely dismissed as simply being misinformed. We were continuously told that it was not possible that these wrongdoings were taking place at TCC. If TCC were performing these acts, the DEC engineers would be aware of it. Being treated by the regulator as if we could not have pertinent information just because we were citizens developed an underlying distrust between us. We eventually began to question whether the DEC was truly working in the community's best interest.

Eventually, and with all our evidence in hand, we were able to factually and intelligently challenge the DEC. In 2010, when EPA arrived to assist in the investigation of the TCC, we finally had our knowledge of the plant's activity truly heard. Many of the violations that the EPA uncovered confirmed our accusations as citizens. We believe that at least part of the reason the EPA's investigation was successful was because EPA used us as a source of reliable information. The DEC, on the other hand, prolonged TCC's emissions because they chose to use the more common viewpoint among engineers and other experts that the public, although having the best intentions, is not to be taken seriously. Through their collaboration, the EPA and Tonawanda residents successfully reduced benzene levels by 86 percent. In addition, with input from the community, TCC's new Title V air permit will reflect many changes to help better protect the public's health from hereon forward.

Early in the development of our organization it became clear to us that experts held stereotypes about the public, the public held stereotypes about experts, and the key to our success was going to be relationship-building. Our experience with the TCC case taught us that experts and the public, both, have much to learn from listening to one another. Citizens are very observant of their surroundings and can offer

valuable information to experts. Just because they don't know all the terms and science behind what is happening does not mean that they are not witnessing results, patterns, and other important information. They are the ones with the finger on the pulse of their community. They might not have the formal knowledge of an engineer or scientist; however, they do have a keen knowledge of their own bodies and environments, which should never be discounted as insignificant. On the other hand, citizens need to understand the institutional constraints under which engineers often operate. It took our organization a tremendous amount of effort, for example, to explain to the community early on that regulators do not have the power to simply force a company to turn off the "pollution switch." In our case, as the stereotype barriers were broken down, we achieved a collective partnership amongst regulators, our organization, and citizens, which allowed our common goal of reducing benzene to be achieved.

It now seems apparent to us that the importance of listening needs to be incorporated in the young engineer or scientist's education at an early stage. One of us is an engineering student himself and knew from the beginning of the TCC case that engineers often view the public as lacking education. As a member of our organization, however, he also knew that the public is a valuable source of information. Therefore, he felt that it was paramount to share this understanding with fellow students in our partnership with Virginia Tech.

Listening is an act of mutual respect. It has the power to break down walls between engineers and residents in any given community. Listening enables people to let down their guards and assumptions in a way that also has the power to transform relationships. Despite temptations to detach or disengage, we hope that future engineers will be mindful that their job will not always be solely about numbers and data. Many times in their careers they will encounter a whole new element in their work, the human element, and it will be vital that they listen to, understand, and value that.

Erin Heaney, Executive Director, CACWNY

CACWNY was founded by Tonawanda, NY residents who believed that their health problems were linked to the 53 industrial plants in their town. Our members are not your typical "environmentalists" – most are working-class and low-income white folks and many do not have a generally "liberal" political orientation. The organization was founded on and has continued to assert principles that run in direct contrast to the three ideological pillars of what has been called the "culture of disengagement" in engineering education. Specifically:

a. Depoliticization (Politicization): Our members' experiences have demonstrated again and again that the public sphere is where decisions are made. The idea that engineering and science can or should be independent of social influences is naïve at best and dangerous at worst. Our experience has taught us that technical research in environmental health and

environmental-health policy-making are inherently political. Moreover, they nearly always place residents in my community at a unique disadvantage because we lack the economic and political power of other constituents (e.g., industry, government, academia, other citizen groups with privilege and direct access to decision-makers). For us to even get close to the negotiating table (let alone claim a seat at it), we must overcome obstacles that demand an inordinate amount of time, work, and commitment, as well as resources that are hard for us to come by.

b. Technical/Social Dualism (Technical/Social Inseparability): We are as concerned about the *impact* of scientific work on our community as we are about the *integrity* of scientific research and *soundness* of new technologies. In fact, we view the technical and social dimensions of the scientific enterprise as inseparable. We value social competencies just as highly, if not more, as technical competencies. In the world of environmental health and public policy, social competencies such as active listening, relationship building, and facilitation of stakeholder meetings are as critical as technical information. We express this view by making it a priority to teach our members leadership skills just as we teach them scientific facts about ultrafine air particulates and epidemiology. We support (and expect) technical and social competence on all sides. The best scientists and engineers we have worked with are those who have had the social competencies to work collaboratively with our members, listen to their knowledge and observations, and use this experience to improve both their research and their relationship with our community.

c. Meritocracy (Inequity): We don't believe that people always get what they deserve or that those who are considered "successful" by our society's standards necessarily got there because they worked harder or were smarter than others. We believe that the social structures that govern decision-making are not generally fair or just. We recognize the role that race, class, and other forms of privilege play in how society picks "winners" and "losers."

Our principles do not represent a specific "ideology." They come out of the lived experiences of our organization. Our members have a long-standing history of interactions with professionals whose conduct reflects a culture of disengagement. In practice, this culture manifests itself through expert actions that dismiss local health-related knowledge and concerns, silence the voices of underserved and underrepresented constituents, and all too often prolong or exacerbate public health and environmental harm. This systemic disinterest in the welfare of our members isn't unique to our region. It is felt by communities throughout the country and the world.

That low-income communities and communities of color are underrepresented in environmental health research, policy, and civic life has been well-

documented.[68,69,70] In 1987 the United Church of Christ's Commission for Racial Justice published *Toxic Wastes and Race in the United States,* a report that showed that race was the single most important factor in determining where toxic waste facilities were located in the United States.[71] The report also showed that the location of these facilities was the intentional result of local, state, and federal land-use policies. Subsequent research spearheaded by sociologist and environmental justice pioneer Dr. Robert Bullard demonstrated that race and class are still strong indicators of whether or not a community will receive environmental protection.[72,73] This holds true today in NW Erie County, NY, where Tonawanda is located. Policymakers routinely downplay our members' concerns about their health and dismiss possible links to the industrial emissions in their neighborhoods.

In contrast, CACWNY fosters a "culture of engagement." We facilitate collective action to make silenced voices heard in order to render environmental health research and policy more protective of public health. Key among our focus areas are a) member trainings on technical and regulatory matters, such as how to review and comment on an industrial facility's Title V air permit, b) community-based research, such as air monitoring, c) member trainings on leadership skills that include grassroots lobbying and working with the media, and d) collective action campaigns to pass policies that protect public health and the environment.

What I cannot stress strongly enough is one simple, but extremely important, fact: no matter how Herculean and outstanding our efforts are, they cannot get us very far if the people in positions of power – scientists, engineers, public health professionals, policy makers – do not listen to us. Listening is one of the most crucial connecting links between our members and the authorities in positions to protect public health. We have seen time and time again that experts within the system who are skilled listeners have been able to help the communities we work with achieve significant change. We have also seen experts who were rude, disrespectful, and horrible listeners. These individuals not only ignored and belittled, they also offered unsubstantiated assurances or contributed to the prolongation of hazardous exposures – acts we consider unethical.

Our decision to partner with Virginia Tech's "Engineering Ethics and the Public" came out of our experience with the negative consequences of the expert culture of disengagement. It is clear to us that if we are to create just and fair public health systems, responsible corporations, and relevant regulatory regimes, we need experts working and leading these institutions who understand, trust, and value the public. The community/academic partnership we built ensured that both the community and the students benefitted. Unlike many models of community/academic partnerships, we took time to negotiate what the community needed in order to ensure that we were entering a fair and equitable endeavor. This kind of a model is rare. We received a small stipend for the staff time it took to connect students with stakeholders, speak with students, and help prepare and lead the class. We also used this collaboration as a leadership development opportunity

for our members to practice a number of skills including public narrative, self-refection, and developing and giving public presentations. The pedagogy of the course treated our members as experts by affirming their knowledge. This experience contributed towards building the confidence of members and reinforced the organization's assertion that their experiences and knowledge should and must be listened to and respected by decision makers.

Our partnership with Virginia Tech helped contribute to small transformations in many of our members and students as well. And as we continue to create spaces for transformation on the individual level, within our community and through our interactions with scientists and engineers, it is essential that we find ways to bring parallel transformation to the institutional level. Our goal is to see formal public participation become meaningful, and ensure that community priorities, needs, goals, and knowledge actually influence both science and policy.

Yanna Lambrinidou, course co-founder and co-instructor, Virginia Tech

It has been said that, "good ethics depends upon good facts."[45] "Engineering Ethics and the Public" strives to teach students that official renditions of engineering controversies often omit or misrepresent the voices of communities directly affected by technical research, decisions, practices, and actions, and that sound moral reasoning and action requires the "facts" of ethical dilemmas to include these voices. My extensive study of the Washington, DC lead-in-water crisis of 2001-2004 suggests that some of the most egregious acts of wrongdoing in engineering and science seem to be carried out by experts whose mindset reveals a stark disconnect from the publics they are supposed to serve. Coupled with increasing calls for socially engaged engineers who can *listen* to marginalized voices in order not only to fill knowledge gaps but also to *connect*, it seems that there are strong reasons for the incorporation of listening into engineering ethics education.

Our pedagogy allows students to discover universes of important information that are rarely, if ever, revealed in their formal education. Our approach also places members of the public in the position of "knower" and "teacher" whose points of view have technical and moral significance. The experience can be empowering for both parties. Stakeholders who are used to being ignored are now heard, their expertise is valued, and they gain experience interacting with and teaching technical experts. Students, who are trained to think that their research must stay within the confines of conventional disciplinary paradigms, realize that they are agents of their own learning, and that they have the capacity, if not moral obligation, to look beyond familiar territories for information. In this process, they can a) acquire knowledge that strengthens their technical and moral understanding of a case, b) gain clarity on their own professional identity and values, and c) experience their field of expertise through a lens that helps them connect with and find meaning in their work. After all, the vast majority of engineering students are visual, inductive, and active learners, all characteristics which are highly

compatible with the demands of ethnographic listening.[74] Our hope is that when our students encounter ethical dilemmas in the workplace, they will draw on the tools and insights from the class to carve a morally examined course of action.

Student assessments of our pedagogy through two pre- and post-instruction surveys – the Engineering Professional Responsibility Assessment (EPRA)[75] and a qualitative survey about the course's four thematic units – are in the process of analysis. We are aware, however, and have been informed by students who took our class in the past that impacts of the experience on professional behavior can become evident long after the class's completion. "Engineering Ethics and the Public" is a work in progress. The challenge of our pedagogy that concerns me the most is ensuring that students and stakeholders alike benefit and benefit equally from the course's educational partnerships. Human interactions between strangers are not always easy and do not always go as planned. Conducting interviews, for many engineering students, is an intimidating task. Giving interviews, for many stakeholders, can be unfamiliar, frightening, and demanding of time they don't usually have. How do we best support both parties to have a fulfilling and successful experience? How do we cultivate and sustain long-term collaborative engagement that is not extractive, but that fosters mutual growth and transformation? Is what we give back useful? Enough?

Conclusion

Today, publics and scientific counterpublics across the country and the world are demanding greater participation in engineering, science, and public policy. This is at least in part because engineering, science, and public policy tend to come out of expert spheres of disengagement and often fail to protect the public's safety, health, and welfare. As German sociologist Ulrich Beck maintains, life in our self-endangering "risk society" is replete with a historically unprecedented host of risks.[76] These risks are created largely by dominant institutions, which assume little responsibility for their actions. Citizens are becoming increasingly cognizant of this accountability vacuum – which Beck names "organized irresponsibility" – and are led to the conclusion that to protect themselves from harm, they have no one to turn to but themselves. Their shield is self-education. In Beck's risk society, dominant institutions may attempt to drown dissenting voices, but they are "unable to remain stable in the face of new 'conflicts of accountability' as disputes erupt over how the consequences of risk can be 'distributed, averted, controlled and legitimated.'"[77]

Our pedagogy of listening aims to offer students an alternative to their education's "culture of disengagement" that empowers, inspires, and motivates them to practice not through "god tricks," but through collaborative engagement with society. Engaged engineering holds promise for making possible new research, technologies, and solutions that are better able to minimize risk, prevent harm, and improve the condition of humankind. Our challenge is to cultivate such transformation not only on the individual level, but also within the very institutions that produce and reproduce our "risk society."

The NAE's vision for the engineer of 2020 closes with the following statement:

> What attributes will the engineer of 2020 have? He or she will aspire to have the ingenuity of Lillian Gilbreth, the problem-solving capabilities of Gordon Moore, the scientific insight of Albert Einstein, the creativity of Pablo Picasso, the determination of the Wright brothers, the leadership abilities of Bill Gates, the conscience of Eleanor Roosevelt, the vision of Martin Luther King, and the curiosity and wonder of our grandchildren.[16]

To this list we add "…and the passion for listening of Studs Terkel."

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