Professional Formation of Engineers' Conceptions of "the Public": Early-Concept Exploratory Research

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Professional Formation of Engineers' Imaginaries of "the Public": Early-Concept Exploratory Research

The notion that engineers apply technical expertise to address societal problems lies at the heart of official articulations about the engineering profession.[1] Seminal publications by the National Academy of Engineering (NAE) refer to engineers as "a key force in the improvement of our economic well-being, health, and quality of life,"[2] as forward-thinking innovators who "make a world of difference,"[3] and as agents of technical solutions that can "ensure the sustainability of civilization and the health of its citizens, while reducing individual and societal vulnerabilities and enhancing the joy of living in the modern world."[4] Promoting this vision, the Engineering Accreditation Commission of ABET requires engineering programs to instill in students "an understanding of professional and ethical responsibility," "a knowledge of contemporary issues," and "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."[5] Official visions of engineers of the future reinforce the profession's service ideal by emphasizing the relational dimension of engineering through references to engineers' inextricable connection to society. Cementing the profession's aspiration to promote the social good is the engineering Code of Ethics, which requires practitioners to, first and foremost, "hold paramount the safety, health, and welfare of the public."[6]

A critical look at actual applications of engineers' technical expertise, however, shows a far more complex picture of the engineering profession's societal impact. Just in recent months, the nation reeled from news about the Flint, Michigan drinking water crisis of 2014-2016.[7] Engineers at the Michigan Department of Environmental Quality (MDEQ) played a central role in the State's cover-up of lead contamination,[8] revealing disturbing parallels with the Washington, DC lead-in-water crisis of twelve years earlier.[9] Both events resulted in a dramatic increase in elevated blood lead levels among children.[10,11,12] The District's contamination was also associated with an increase in fetal deaths.[13,14] In March 2014, following years of resident protests about black soot and high cancer rates, a federal judge fined a foundry coke plant in Tonawanda, NY $12.5 million and sentenced the plant's engineer and environmental controls manager to one year in prison for knowingly emitting into the air cancer-causing benzene in violation of federal laws.[15] In September 2014, the House Energy and Commerce Committee of the US House of Representatives issued a report assigning blame to the National Highway Traffic Safety Administration (NHTSA) for contributing to 30 deaths and 31 injuries that resulted from defective General Motors (GM) vehicles. According to media reports, between 2003 and 2014, automotive engineers at NHTSA had received over 260 consumer complaints about GM cars suddenly shutting down while in motion, but had deemed these complaints insufficient for triggering an investigation.[26] What ties these cases together is that, whether they entailed legal violations or not, they all involved engineers' disregard for the safety, health, and welfare of the public. There is little evidence to suggest that failures such as these are unique, except perhaps in the sense that the specific transgressions identified were documented and publicized.

These and a growing number of similar cases were first exposed by concerned and affected publics, illustrating that citizen experiences, knowledges, values, and goals have the capacity to complement and even strengthen engineers' work and moral conduct.[16,17,18,19,20] Yet the over two million practicing engineers in the US today often make complex and critical decisions with significant implications for the public's health, safety, and welfare in a relational vacuum, where

publics are imagined rather than engaged with. In our 2015 proposal to the National Science Foundation's (NSF) Early Concept Grant for Exploratory Research (EAGER) program, we contend that engineers' imaginaries of "the public" likely influence practitioners' ability to serve as 21st century agents of change who advance the human condition without causing or perpetuating harm. Our use of the term "imaginary" is based on Taylor's conceptualization.[21] It refers to a continual "making sense of" negotiated normative expectations, moral orders, and social relationships that shapes the worldview and guides the practices of a social group. Drawing further from the work of Jasanoff and Kim,[22] we posit that in the engineering profession the formal and informal processes through which individuals become engineers cultivate a certain kind of "making sense of" the engineer's professional life. This "making sense of" shapes, among other things, engineers' imaginaries of "the public" in contradistinction to their conceptions of themselves. Postulating that different imaginaries reinforce different ideologies and different kinds of professional identity and practice, *we hypothesize that engineering education promotes imaginaries that distance engineers from the communities they serve*. In this process, the public becomes a rhetorical, as opposed to an empirical, space that reinforces the engineering profession's service ideal and legitimizes engineers' work as promoting the social good, regardless of how diverse publics articulate their own visions, define their own needs, and envision the role of technological applications in their own lives. In light of psychological research establishing a link between professional distancing from those who might be affected by one's actions, moral disengagement, and unethical decision-making[23,24,25,26] *we suggest that this rhetorical space comprises fertile ground for suboptimal professional decisions, unethical conduct, and ultimately public harm.*

The premise behind our study is that knowing *what* imaginaries of "the public" engineering education fosters and *how* these imaginaries might separate engineers from society can support engineering faculty to cultivate in their students alternative ways of thinking that render publics visible, underscore the technical relevance of their voices, and give them a well-defined role in the engineering enterprise. As a first step toward this goal, we have initiated research in engineers' imaginaries of "the public" – what these imaginaries are, how they form, and how they are expressed in engineers' interactions with "the public." To explore these questions, we are examining a) official engineering documents that frame the profession's discourse around engineers' relationship with society, b) perspectives of engineers, and c) perspectives of members of what Hess calls "mobilized" publics.[27] As groups that stand in opposition to specific engineering decisions, technologies, or practices and that strive to be heard, mobilized publics might offer insight into how engineering imaginaries are expressed *in practice* and affect critical points of contact between engineers and society. Community perspectives may also highlight important aspects of what it is like to *be* "the public" that engineering imaginaries might distort or overlook. We anticipate that our proposed research has the potential to play a defining role in helping us envision alternative engineering imaginaries that can strengthen engineers' commitment to the social good and better support scientifically robust and morally sound technological interventions.

Whether or not engineering education trains students explicitly on how to think about the public, it always sends implicit messages about who the public is, what it knows, and what it needs, through both formal and informal processes of professional formation. These messages, in turn, likely inform the way in which engineers understand their professional responsibilities to society as well as apply their technical expertise. In practice, different conceptions of the public may translate into different visions of the public's resources, capacities, and potential roles, and

may result in significantly different ways of identifying problems, generating ideas for solutions, designing technological interventions, and responding to complexities, uncertainties, and tensions along the way. This, in turn, may have direct implications on engineers' ability to *see* diverse publics, *hear* diverse voices, and appreciate the potential value of diverse solutions in different circumstances and contexts. Linking students' imaginaries of "the public" to their future decisions about what epistemological approaches to adopt and how to exercise their professional power, the proposed research poses the following important questions:

> Q1: How do engineers perceive the public?
> Q2: What formal and informal processes in engineers' professional formation shape these perceptions?
> Q3: Do these perceptions present differently in engineers at different stages in their professional formation and, if so, what factors precipitate these differences?
> Q4: How are these perceptions expressed *in practice* and what impact might they have on engineers' relationship with diverse publics?

Drawing on Keller's theory that "the traffic between ordinary and technical language works as a carrier of [...] ideology into science,"[28] we anticipate that the first two sources – official engineering documents and engineers – will reveal language that helps bring into sharp relief *what* engineers' imaginaries of "the public" are, *how* they are formed, and what ideologies they may promote. The third source – members of mobilized publics – has the capacity to offer insight into how engineering imaginaries are expressed *in practice* and affect critical points of contact between engineers and society. Community perspectives may also highlight critical aspects of what it is like to *be* "the public" that engineering imaginaries might distort or overlook. We anticipate that our proposed research has the potential to play a defining role in helping to construct alternative imaginaries that can strengthen engineers' commitment to the social good and better support socially- and morally-sound technological interventions.

Our study intends to advance knowledge about the construction of the engineering identity in relation to one fundamental element: how engineers are formed to imagine "the public." Inextricably connected to the profession's core value – to "hold paramount the safety, health, and welfare of the public"[9] – engineers' imaginaries of "the public" lie at the heart of the engineering profession's mission. Improved understanding about these imaginaries – what they are, how they are formed, and how they are expressed in practice – can begin to shed light on the ideologies that inform the critical and challenging "boundary" that engineers are trained to raise between the profession and its primary but often invisible client: society. As such, our research may constitute a first step toward deeper insight into how these ideologies enhance or weaken engineering practice and, ultimately, how they support or undermine the profession's aspiration to promote the social good.

Work to date

The research team has begun to compile and code engineering documents with respect to the ways in which the public are presented and the relationship between engineering and the public are represented. Table 1 shows the documents that will be coded. One element of this research plan is that Learning Through Service (LTS) may provide a different view of the public, therefore selected material from the LTS literature will also be examined.

Table 1. Professional documents to be coded with respect to imaginaries of the public

Document Type	Specific Documents
Professional Documents	NAE – The Engineer of 2020: Visions of Engineering in the New Century
	NAE – Educating the Engineer of 2020: Adapting Engineering Education to the New Century
	NAE – Changing the Conversation: Messages for Improving Public Understanding of Engineering
	ABET – Criteria for Accrediting Engineering Programs
	IEEE Strategic Plan
Disciplinary Bodies of Knowledge	ASCE – Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future, 2nd Ed.
	ASME – 2028 Vision for Mechanical Engineering
Codes of Ethics	NSPE Code of Ethics for Engineers
	ASCE Code of Ethics
	IEEE Code of Ethics
	ASME Code of Ethics
Ethics Textbooks	Martin et al. – *Engineering Ethics: Concepts and Cases* – Chapter 4
	Martin & Schinzinger – *Ethics in Engineering* – Chapters 1 & 2
	Van De Poel & Royakkers – *Ethics, Technology, and Engineering* – Chapter 1
Learning Through Service Literature	Ed. Tom Colledge – *Convergence* – Chapters 1 & 2
	Lima & Oakes – *Service-Learning Engineering in Your Community* – Selected Chapters
	Engineers Without Borders – Strategic Plan

The research team is in the middle of coding, using emergent thematic coding around imaginaries of the public. Though this coding scheme is still in development (but will be complete by the conference in June), themes have clustered around the following larger categories:

- Characterizations of the Public (e.g., "Technologically illiterate")
- Professional duties related to the public (e.g., "Solve Problems")
- Relationship between engineers and the public (e.g., "Cross Disciplinary", "Collaborative")
- Engineers social footprint over time (e.g., "Increasing")

- Societal problems/issues in need of engineering solutions (e.g., "Physical Infrastructure Stresses")

A fuller discussion of emerging themes and their prevalence in engineering documents will be ready for inclusion in the poster as part of this session.

The research plan moving forward includes interviews with engineering students, faculty, and professionals, drawing upon the themes discovered in the professional documents analysis and from the theoretical foundation in social imaginaries. After analysis of these interviews is underway, interviews with members of "mobilized publics" will be conducted to examine this relationship from both sides.

Acknowledgements

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