Chapter 21
Engineers, Social Scientists, and Nuclear Power

A Narrative from Within

Cathryn Carson

Abstract The PAGES collaboration (University of Tokyo and University of California, Berkeley) brought together nuclear engineers and social scientists to try out new ways of engaging engineering graduate students with societal issues around nuclear power. The program was built around seminars and summer schools. Because of the Fukushima Daiichi disaster, it ended up culminating in a weeklong program for students in summer 2011 to examine the Fukushima Daiichi accident as a socio-technical catastrophe and an invitation to rethink nuclear engineers' possible roles in a post-Fukushima world. This chapter reflects on the PAGES collaboration and the Fukushima Daiichi summer school from the perspective of one of the social scientists involved. It narrates the experience of collaborating across disciplinary boundaries at a moment of challenge and in a space where social science is not well anchored to start. Out of this narrative, the chapter aims to draw some potentially generalizable suggestions for social scientists who are trying to engage engineers and graduate students, given the constraints of time, attention, and trust.

Keywords Nuclear engineering · Social science · Methodology · Collaboration · Engineering education · Graduate education · Nuclear waste management · Fukushima Daiichi nuclear accident

21.1 Introduction

This book is the product of an exchange between nuclear engineers and social scientists, one that has been productive and unsettling for all of us involved. Like many productive encounters, it came about somewhat by chance—a set of

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contingencies, relationships, and openings that shifted shape as they unfolded. Like many unsettling processes, the participants went into it with a mixture of attraction and wariness, unclear how we would be defining our roles. I have been involved in the collaboration called Program for Advanced Graduate Education System for Nuclear Science and Engineering with Social Scientific Literacy (PAGES) in a looping fashion, moving in and out of phases of more intense engagement as PAGES's own dynamic evolved. As other chapters in this book explain, that collaboration had been underway for several years when the Fukushima Daiichi disaster turned our heads around.

As a historian and social scientist, I came into the collaboration with a set of internal questions: Where are the openings for social scientists to be part of nuclear engineering graduate education? What could social science literacy for nuclear engineering students even mean? Are there ways to bring social science to bear that do not simply instrumentalize it as another tool in a toolkit? The PAGES effort became an exercise in trying out answers to these questions. In my own sense of things, it proceeded with a deep curiosity about how to think about the problem systematically, yet in what I have come to think of as an engineer's fashion: testing out several things with more or less theoretical justification, seeing what worked and learning from what failed.[1]

At the end of the process, my conclusion is threefold:

- It does not work to come at this challenge by lecturing on the great insights and results from the social sciences that ignorant engineers need to be taught. Engineers are social analysts, too—more or less observant and savvy, depending on personality and experience, but sometimes incredibly astute in their own professionally conditioned way. That shift of perspective is, for me, a key piece of reflexivity. If their expertise is constructed, then mine is as well, a recognition that has led me to be more explicit about explaining where my own disciplinary strategies come from.
- If social scientists choose to try to be useful to engineering students, it works better to start with them where they are, with their own observations, puzzlement, and questions, and then see where those connect with social science analyses. This at least starts the process. Having a crisis to work with can help. The challenge is to get far enough down the road that "social science" has some actual bite. Otherwise it just comes across as an invitation to soft-focus reflections on pre-formulated dilemmas that engineers already believed they could tackle with their own informal theories about how the social world works.
- Then the biggest open question for me is how to crystallize what social science has to offer. There is a ready tendency to reduce it to its subject matter: generically, engineers understand "social science" to be about "society," conceived in flat terms as this thing other than the engineering they do. But social scientific inquiry is defined not just by subject matter, but by methods. Thinking

[1] Downey [1] and Sørensen [2] have been critical touchstones.

like a social scientist means not just knowing stuff about society, but asking particular kinds of questions using distinctive concepts and analytical strategies. Conveying these in short educational interventions is hard.

The PAGES experiment, and especially the 2011 summer school around the Fukushima Daiichi disaster, was most satisfying when it was able to build on students' preexisting dilemmas, addressing questions they did not have answers to and using language they spoke. This is an approach that is educational in a sense of the word that is only somewhat in tune with contemporary understandings within nuclear engineering.[2] In nuclear engineering, education within classroom settings is still largely a matter of one-way conveyal of preselected information, a model of communication that also governs the nuclear community's interactions with the public. One of the main contributions that social scientists made to the PAGES program, in fact, was to simultaneously pry open the concepts of communication and nuclear engineering education, particularly students' agency within it.

Any engagement of social scientists with engineers (at least as social scientists analyze it) is structured by differentials of power. But those differentials are not always the obvious ones. They can be modulated through personal connections, and for us they shifted across the boundary of the Fukushima Daiichi disaster. My aim in this chapter is to offer some reflections on that experience from the perspective of a participant whose professional trajectory has been profoundly shaped by it—but whose professional position does not require particular canons of presentation (starting from technical facts, downplaying confusion or conflict). At the same time as my reflections make a move of deliberate abstraction, they are structured by an admiration for my colleagues' intellectual and personal honesty that I hope can shine through.

21.2 Paths into the Project

My own training is as a historian of science and technology; my intellectual affiliations bring me into the arena of science and technology studies (STS). For scholars who share this training and mindset, the rise of nuclear power is part of a standard historical narrative of the scientization of twentieth-century life, as a new class of technical experts emerged around the conjunction of nuclear energy, both civil and military, with the post-World War II state. Some of the concepts we use for making sense of the nuclear present include the traces of a top-down policy regime structured by decide-announce-defend (DAD) rather than deliberative engagement, legacies of public distrust of nuclear institutions and spokespersons, and a strong sense of a historical alliance between the state and the nuclear industry in countries around the world. These are not always concepts whose

[2] See especially Sunderland [3] and Oda [4].

articulation is welcomed by inhabitants of the nuclear world, at least not in the way that social scientists who live outside of that world have chosen to do it. In working within GoNERI, it was important to acknowledge that mismatch, for instance, by pointing to scholarship (books) that had shaped my work that nuclear engineers would probably never read (Fig. 21.1).

I am consciously neither pro-nuclear nor anti-nuclear; my preference is to work on topics about which I am profoundly ambivalent. In the background is a long-term fascination that I myself do not totally understand with nuclear power and the nuclear industry, a engagement anchored a childhood that included excursions to nuclear power plant visitor centers (back when those were easy to get into) and a high-school trip to learn about the Three Mile Island cleanup at first hand (I still have a t-shirt with the plant systems diagrammed on the front). For better or worse, that early technical fascination with systems and accidents gave me an unusually refined knowledge, at least for a historian, of PWRs and BWRs and LOCAs and accident sequences and other such things. It was that exposure, combined with the training I had in physics, that played into my comfort with tackling a long-term project of historical research on the intellectual technologies of risk assessment in nuclear waste management. Formalized risk analysis is a great topic for historically minded social science, given the way it alternately rationalizes and repudiates living experiences of being at risk.

Fig. 21.1 Slide of background literature, late 2008. (*Top row* [5–8]; *Bottom row* [9–12])

In the context of that project on radwaste and risk, I came to know my colleagues in the Berkeley department of nuclear engineering over the span of a decade and more. In 2006–2007 I was lucky enough to take a year off from my own teaching and attend graduate and undergraduate classes in the Berkeley NE department, with a focus on nuclear waste management (and thus the greatest number of classes with my co-editor, Joonhong Ahn). Along with the technical material, I was learning the ways of thinking and modes of analysis that create knowledge in this domain, sitting with the students in classrooms and seminar rooms as they took in the professional cues and formation that made them into nuclear engineers. It was this curiosity that made it interesting to agree when my faculty colleagues invited me to participate in an early 2008 workshop of the Global Center of Excellence program called "Nuclear Education and Research Initiative" (GoNERI) that bridged recently initiated efforts (in 2007) at the University of Tokyo to a local Berkeley base.

21.3 Searching for Fit

The topic of this GoNERI meeting on January 6–8, 2008, was "Nuclear Technology and Society—Needs for Next Generation." A historian who has spent time among engineers has expectations about how these meetings unfold. There are ceremonies and speeches expressing aspirations to serve society with advances in technology.[3] There are lots of technical talks from professors and other high-status people, supported by powerpoint slides. In this case the meeting's technical agenda was overlaid with an emphasis on international collaboration and a getting-to-know-you-better function between engineers from Berkeley and Tokyo. Because of the formalities of sponsorship by the Japanese authorities, there was a significant effort at documentation; the proceedings of the workshop were prepared and ran to nearly 400 pages [13].

In meetings such as these, historians often get slotted to provide a historical perspective, or to generally speak about nuclear power and society. The nuclear community has long-established ways of thinking about society, which can be pretty well captured in a schema like Fig. 21.2.

This was in fact the first slide from my GoNERI talk. It was a move of abstraction, using the license afforded by distance to speak in a direct voice. The second slide (Fig. 21.3) got a bit more theoretical.

I was hoping to bring something foundational into view. Even when engineers are savvy operators, they often work from folk theories of society: familiar framings of societal processes and social order that live within a structure of their professionally reinforced ways of understanding their experience [14, 15]. Without pointing this out this openly, was there any hope of making the case for something else? In my first try at speaking in this setting, what came next was too abstract

[3] There is no irony or sarcasm in my voice here or elsewhere in this chapter.

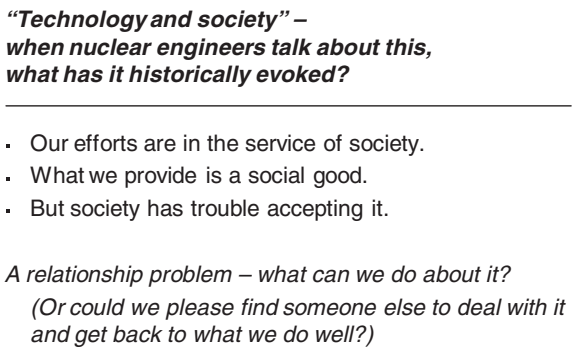

Fig. 21.2 Slide 1, early 2008. *Source* Cathryn Carson, UC Berkeley, 7 January 2008. Workshop on "nuclear technology and society—needs for next generation." © Cathryn Carson 2008

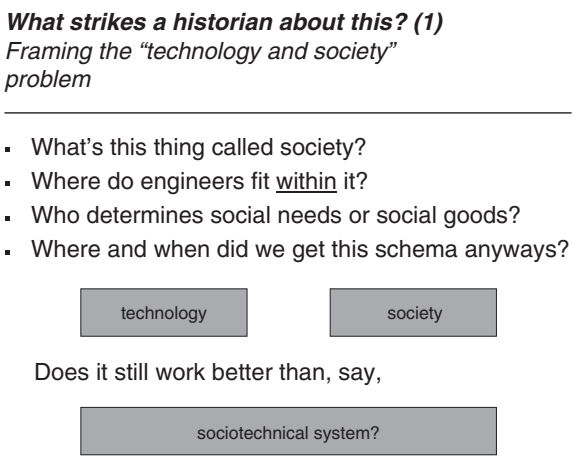

Fig. 21.3 Slide 2, early 2008. *Source* Cathryn Carson, UC Berkeley, 7 January 2008. Workshop on "nuclear technology and society—needs for next generation." © Cathryn Carson 2008

and theorized. Engineers can be polite when they are being presented with things that don't really speak to them. I am still left with the puzzle: Why is it the case that concepts that to me feel so powerful for grasping the world (e.g., sociotechnical system) fail to capture the experience of the people actually living that life?

On the other hand, it was interesting to see where the direct language of opening gambit resonated. And the move to situate the speaker (myself) within a particular disciplinary tradition seems to have been both interesting and curious. The notions of perspective and subject position are fundamental to the way I do my research, but these seemed so disablingly relativistic to non-social scientists that they did not quite believe I wanted to play them up.

Over the next years, as the GoNERI team pulled me in, we all grappled with different ways to connect social science with questions that nuclear engineers and

their students found worth engaging. One entry point was a focus within PAGES on societal issues around nuclear waste management, a specificity that was more manageable than the whole narrative of nuclear power, even as it could be backed up against that larger history for context. In general, if social scientists hope to provide more in engineering education than the cultural patina of "breadth," specificity feels like the way to go. In seminars and discussions I tried presenting substantive historical episodes that I found instructive for my own thinking—stories from my radwaste research about the negotiated processes that created the present set of (sometimes arbitrary-feeling) regulatory specifications, the partly contingent paths by which current technically favored approaches came to the fore, past disposal concepts that in their day had wide acceptance but now looked startlingly simple-minded, or the history of the US radwaste program's attempt to engage social scientists in what was framed at least from the 1970s forward as a social as much as a technical problem. Thinking through cases is my bread and butter as a historian. However, I never sensed that anything I said about specific historical examples stuck with my listeners. At most, the concreteness of the cases was an occasion to build credibility by displaying a decent mastery of radwaste language and facts.[4] A related strategy had even less uptake: working through comparison cases in order to suggest generalizations. We were supposed to be talking about nuclear engineering, so lessons from, say, nanotechnology did not feel relevant to my partners—though the comparison cases profoundly shaped my own ways of analyzing societal dynamics around nuclear power [14, 17].

Another strategy was foregrounding methodology, highlighting the different ways to get one's head around a question. One big goal here was just to make visible that there *are* different ways to analyze the world: questions it makes sense to ask, strategies to delimit a researchable problem, research approaches and tools to use, ways of talking and arguing that govern how we analyze and discuss. Then part of the value of social science is just that it tackles things differently from engineering, and that has a reflexive payoff—the insistence that there is not some single univocal understanding of a situation, one that (in our students' case) engineering analysis delivers. In that sense, the point was to underline that there are sightlines that engineering does not provide on its own. A more refined goal was to name and experiment with particular social scientific methodologies, since social science is not a univocal thing either. In PAGES we did a fair amount of naming, but only a little bit of experimenting, which was a source of disappointment if one sees value in learning by doing.

I would have liked to create more space to try out scenarios, simulations, and encounters with real participants, creating practical experience that analytical approaches could be set to work on. Some of that work was done by PAGES collaborators, as mentioned elsewhere in this volume. For the students I staged one example as an exercise in one of the summer schools [18], and, judging by the short-term discussion, it made some impression. The exercise took students through a puzzle: What would be the right way to clean up the Asse II Research Mine in Germany? Asse II was a former salt mine where the "testing" of methods

[4] I relate this to interactional expertise as in Collins and Evans [16].

for of low- and mid-level radioactive waste in the 1960s and 1970s had set the scene for a massive conflict thirty years later, once it was revealed that the mine (assumed perfectly dry) was actually subject to water entry, with radioactivity now accumulating in brine pools, and structurally unstable to boot [19]. Specifically, the students were asked: what questions would an engineer need to get answers to in order to decide what should be done? A non-linear powerpoint deck let us explore student questions in the order they brought them up, starting with the geology and technical parameters, then taking up the local setting, the national context, and the path-dependencies of the history and the institutional and regulatory environment. In the end, the conclusion may have been there was no single right answer for what to do next, a notion that was very comfortable for social scientists, but felt troublesome for nuclear engineers.

Some of these messages and approaches felt incredibly simple, so much so that I was afraid I was being patronizing. But still they resonated with some subset of engineering students and colleagues: staking out a subject position as an analyst, listening for an interlocutor's concerns without going immediately to judge whether they were rational (i.e., technically correct), applying social science analysis to oneself and not just to "the other" (e.g., the public). In practice, this way of working meant presenting social science (itself already a broad and diverse thing) as a set of tools and techniques for tackling a problem, which was an engineering framing itself. Probably for obvious reasons, the tools of social science that seemed most comfortable for engineers to make recourse to have come from economics, along with simplified versions of political science for national policy-making and international relations. Approaches from anthropology, sociology, and history were harder to make stick.

The format, too, was constrained. Any educational changes we tried were likely to sit outside the regular graduate curriculum for now, at least on the Berkeley side. For interpretive social science we could experiment with voluntary seminars and optional summer schools. What was understood to have a place in regular graduate training was, again, those parts of economics and political science/IR that were already appropriated and built in. There are institutional and professional structures that enforce this division of competencies. In addition, across the engineering curriculum here, both graduate and undergraduate, there is a reluctance to have engineering students officially taught by anyone other than engineers.[5]

21.4 Voice, Tone, Trust, and Power

And yet there was real sincerity in the formulation of social scientific goals within GoNERI. The engineers who were involved put this on record early on. Out of their own experience and initial contacts, they felt that they needed to collaborate

[5] Sunderland et al. [20] on Berkeley, more generally Besterfeld-Sacre et al. [21], Christensen and Ernø-Kjølhede [22].

with social scientists, and in order to do that, they needed to understand the social sciences better—their domain, concepts, terminology, and methods. This would mean going beyond the standard nuclear engineers' view (as my colleague Joonhong Ahn described it at one point) that what was needed was better ways of getting societal acceptance of nuclear energy. Instead it would take actually understanding societal structures and processes and listening to the public in order to develop engineering options (note the plural) to explore in some kind of societal partnership. The framing of social scientific literacy, as I understand it, was intended to point to a foundational kind of learning that engineers were willing to take on.[6]

This openness was encouraging against the backdrop of the history of the nuclear community's engagement with social science, which has often been marked by selective listening and instrumentalization, using social scientific techniques in the service of affirming an existing agenda or calling in outside analysts and then doing nothing with their work.[7] What made it plausible to speak plainly within the PAGES project was trust—my confidence in my Berkeley colleague and others he invited in, his openness to the social scientists on the Tokyo side, and our shared willingness to try out controversial ideas on each other. In a strange way, the last of these was facilitated by the language barrier. It was possible to get away with framing things sharply and then apologizing when I could be the bull-in-a-china-shop American, at least by Japanese standards. My understanding is that my Japanese colleagues spoke fairly directly with each other, but that voice rarely surfaced in formal written materials, at least until the present book. Part of the trust also came out of working and traveling (and drinking) together on site visits, including the Waste Isolation Pilot Plant in Carlsbad, NM, and the Swedish interim storage facility, Clab, near Oskarshamn. The challenge was then taking this shared basis for communication and putting it to work for others who were not in the same boat.

This was especially challenging in our summer schools, where other nuclear-world experts were invited into say things that sometimes felt far too simple. And without wanting to reinscribe all social scientists as critics, it felt important to get a critical position in view. That meant finding ways to speak within a polarized nuclear scene where social science is a pretty low-status, half-formalized thing. There were times when my language reflected real frustration—frustration of my own, and that of decades of social scientists before me. Within the PAGES project we had discussions about "nuclear socio-engineering," something that some of our colleagues thought we should be doing in order to generate trust and public

[6] On cross-disciplinary collaboration in engineering education see Borrego and Newswander 2008 [23]. As much as my own instinct is to dig into the "literacy" framing, I took it as a zeroth-order approximation I could work with. It did significant work for the team that pulled together the GoNERI social scientific component before I was involved.

[7] Years of discussions with Gene Rochlin and Todd LaPorte made this point clear to me. For Japanese reflections see Oda 2014 in this volume [4].

acceptance for the nuclear field. The concluding slides of my presentations—everything always has to be presented in powerpoint—sometimes marched through a set of sharply phrased bullets, seeing how far I could exploit my license to speak.

This *was* an effective way to make certain points. When I used this slide (Fig. 21.4), it kept the NE graduate students and postdocs in the room for several hours. Some of the above bullets showed up in other PAGES participants' powerpoints later, attributed to this presentation I gave. The move to frame things aggressively worked, I am guessing, because within the PAGES group and some parts of the Berkeley NE community there was already a basis for trust, so that I was something more than a frustrated outsider expressing critical views.

And on the public side, it was instructive when my frustration met others'. The 2009 summer school focused on "Radioactive Waste Disposal with Social-Scientific Literacy" [25]. It came just months after the US Department of Energy announced its intention to terminate the Yucca Mountain nuclear waste repository project. The radwaste community was raw with frustration about what was seen as irrational, emotion-driven political interference with good technical work. The tone filtered in and out of a packed program of lectures—rarely in the powerpoints, sometimes in the Q&A, everywhere in conversations in hallways, break times, and meals. It felt like one way to address it, without getting it aimed at myself, was to use a spot in the closing panel to reflect "ethnographically." (I should acknowledge that while I draw on and learn from ethnographic methods in science and technology studies, I am not formally trained in them and put the word in quotation marks out of respect for those who are).

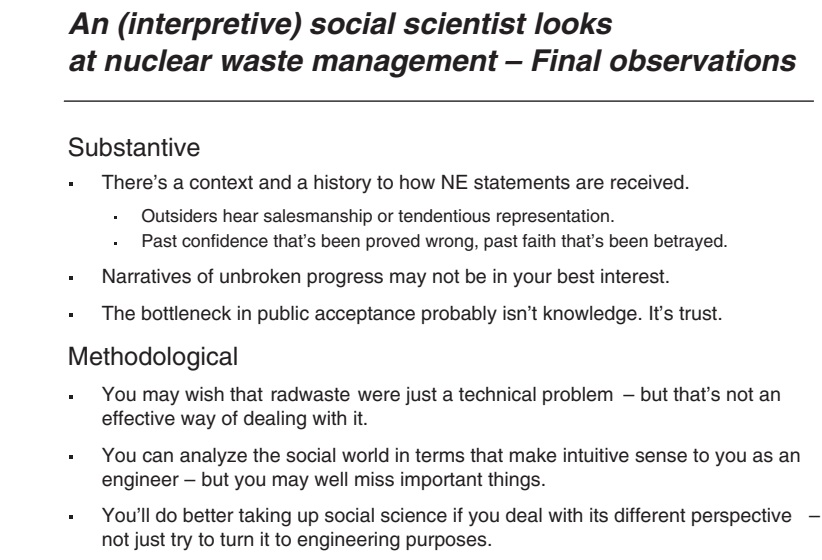

Fig. 21.4 A concluding slide, late 2008 [24]

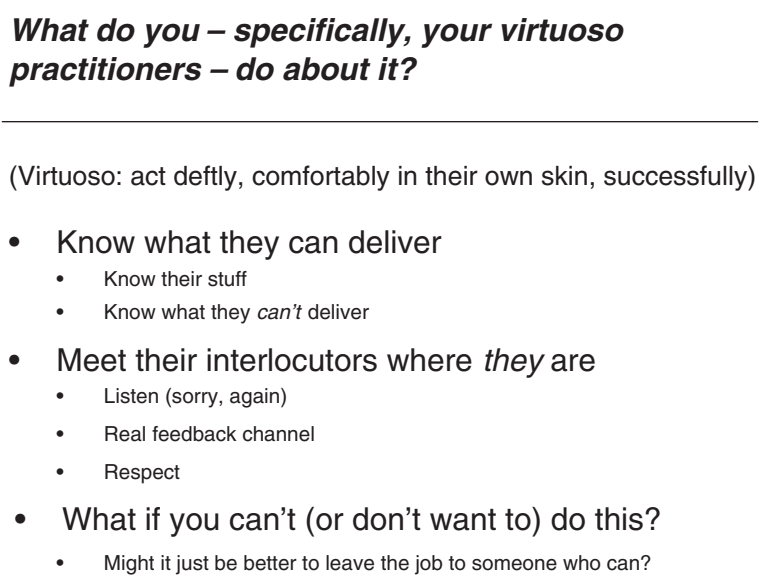

Fig. 21.5 A concluding slide, 2009 PAGES summer school

Struggling hard to be constructive, I ended up with this slide (Fig. 21.5) about (generic) nuclear situations where relations between those two supposedly different things, technology and society, seemed so profoundly frayed.

Actually, the final, cranky bullet point was left undisplayed. It was better to have held it back. The most instructive thing about the summer school was a quiet remark by Joonhong Ahn pointing out that nuclear engineers often feel powerless vis-à-vis societal forces. I had been assuming that social scientists were the only powerless ones.

In truth, much social science scholarship on things nuclear is voiced as critique from below. That is justified in so many ways. At the same time it constrains the repertoire by reinscribing a polarization that blocks other kinds of engagement. Kohta Juraku, one of the core social scientists in PAGES, kept prodding us to try another way: start from the shared value of doing better for the public, de-privilege all participants' contributions, and stop making immediate recourse to the move of critique.[8] Even when this felt impossibly sunny, the reminder was useful. There is a kind of second-order complacency in a lot of critical social science—the world is what it is and will not be practically changed by our work until our views are recognized as right. In PAGES we were grappling with ways to jar that complacency. Ultimately it was jarred from the outside.

[8] Developing this point in both directions, see Juraku [26].

21.5 After the Accident

The Great East Japan earthquake, the tsunami that followed, and the Fukushima Daiichi nuclear accident crossed with our planning for the 2011 radwaste summer school. Initially projecting a meeting in Sweden, our organizing committee was drafting background materials on Thursday evening, March 10, Berkeley time, when one of the Berkeley-based PAGES collaborators emailed with worries about the effects of the shaking in Japan. The next morning, on Friday, we were transfixed by the devastation left behind by the tsunami. Over the weekend, the threat to the Fukushima Daiichi reactors began to come into focus—station blackout, emergency cooling with seawater, hydrogen explosions, indications of at least a partial core melt, external radiation levels far above normal. By Monday, March 14, in the offices and seminar rooms of the nuclear engineering department there was no doubt there was a disaster unfolding. The question was scale. As word came in via websites and even emails of steam explosions and spent fuel pools, the sense in Etcheverry Hall was of an open future potentially spiraling out of control.

Someday I will write down my narrative of a social scientist camped out for long days and late nights among the nuclear engineers that week. It was a pivotal experience of my professional life. The reflections relevant to PAGES center directly on the NE graduate students: their questions about how to speak to their friends and their families, their unrest about the tone of the American Nuclear Society's press statements, their admiration for Joonhong Ahn's counsel of approaching the challenge with—his words—listening and humility. There was a sense among some of the students that this moment would mark a "before" and "after" in their careers, defining them as agents who would choose where to follow their teachers and where to chart their own course.

Already on March 14 we were revising the plan for the 2011 summer school. We were shaken enough that we could not do anything else. The school was relocated to Berkeley and refocused around the Fukushima Daiichi accident. The new topic, in all honesty, was the easy part. The hard part was grappling with what it could mean to meet the students where they were, as independent agents with their own concerns.

In my own teaching, I work in the space between my students' subject positions and the drive to produce intersubjectively compelling accounts. I start from behavioral science literature that indicates real payoffs from having students write down first-person goals and set intentions for themselves. Using "I" in engineering seems to be basically forbidden, however. So is using direct language, at least most of the time. As summer school organizers, we found our way to put a full-page essay question on the application form:

> Outline your current thinking about the Fukushima nuclear accident of March 11, 2011. Describe the issues you see it raising for nuclear engineering professionals and for societies pursuing nuclear power. Discuss what you see as the relevant background and fundamental causes of the accident.

This was abstract enough that it probably did not scare away too many students. And yet as straightforward as it was, to my ear it did not capture the sense of urgency I know we all felt. I still wonder what we would have gotten if we had openly asked for answers to other questions in our minds: Why do you want to come here? What do you want to get out of it? How do you think you will be changed?

21.6 Discussing the Fukushima Daiichi Catastrophe

Other chapters in this book convey the experience of planning and hosting the summer school. The week in August 2011 was eye-opening in so many ways. The students showed an unusual willingness to play along with an experiment that went against much of their previous training. Social scientists are used to deeply unresolvable problems; in fact, we often take pleasure (at least the academics among us) in societal complexity and the absence of a single right answer. Our summer school attendees remarked on their bewilderment: how to chart a course through the thicket of conflicting perspectives and options.

To my mind, the most compelling parts of the summer school were not about content—the lectures by experts, the formulation of problems to be tackled, or even the conclusions that the student teams articulated on the last day. What was most impressive was the process, how it all unfolded. The organizers and discussion leaders managed to make space for future engineers to speak analytically and non-defensively about the failures that led into the Fukushima Daiichi disaster. It was not out of line to talk about the "nuclear village"—and also to subject that concept to some pretty stringent critique. Some students found a voice to speak from their own experience in ways that I doubt they would have tried in a regular NE classroom. Several said that whatever the caveats attached to formal projections of risk, they had never believed that an accident of this sort could actually happen. And now that it had happened, it could happen again. It also took deliberate social engineering to make room for open-ended discussions. Along with turning off the video camera (documenting for the purpose of Japanese reporting to funders) and a no-powerpoint rule for final presentations, it made a difference that we were in a setting outside the classrooms in Etcheverry, in downtown Berkeley, near several bars.

It is tempting to live out of the inspiration of the summer school and to present it in the reporting language of demonstrated success. And yet I do not think of it as a straight-ahead model for future educational programs, at least not in this one-shot form. Asking the students to do little preparation, in a week of lectures and Q&A we could only get so far. When we made our way past the initial technical presentations to take up societal issues, it was not clear that social scientists were seen as having anything different to offer from engineers speaking in the same vein. And in the student discussions, inevitably, the content of "social science"

was largely topical, without much sense of methodological challenge. Social science ended up being about its subject matter, society, rather than about ways of querying human behavior at a level above an individual's consciousness, analytically looking at institutions, structures, or patterns.[9]

I wish I had made more time and space to speak directly to questions about method. (My role in the week was as a co-organizer of the school and an intervener in discussion, but not a formal presenter, for once.) What I believe we actually accomplished in the summer school was learning how to start and structure these exchanges. My own sense is that their success (or not) will be seen off in the future, as the conversations we have started will continue to play out. Reflections in the wake of the summer school by our students and their postdoctoral mentors give me hope [4, 26–28].

21.7 Closing Observations

I have come out of the PAGES project with a more informed willingness to engage with engineering students, structured by a strong sense of the operational constraints. Really engaging the students successfully means starting with them where they are, iteratively exploring with them rather than lecturing at them—whatever the expectations that their own field sets about how education actually works. Exploring in this way is a challenge to do within the framework of their existing curriculum. At least, it is a challenge to do in a satisfactory way. More time and depth are needed to get past the flattening of social science to a set of recognizable tools or a body of largely pre-intuitable societal knowledge. We will need more, and longer-term, engagements if we want to get across its power as a set of alternative methodological strategies for getting a grip on the world.

The starting point for the PAGES collaboration was this realization: interdisciplinary collaboration is hard. That proved true all along the way. When it succeeded in PAGES, the outcome had much to do with trust, voice, and personal relationships. The only adequate way to close is with admiration for those colleagues and NE students and postdocs who made it possible for social scientists to engage with nuclear engineers.

[9] For similar reflections see Sunderland 2014 in this volume [3].

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