An Advanced Educational Program for Nuclear Professionals with Social Scientific Literacy:
A Collaborative Initiative by UC Berkeley & Univ. of Tokyo on the Fukushima Accident

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I. INTRODUCTION

Words such as “interdisciplinary”, “collaboration”, and “social aspects” regularly appear in various nuclear contexts. It is common understanding that we need to bring together a wider range of knowledge and expertise to more appropriately deal with the place of nuclear technology in society.

In order to put this understanding to work in practice, we believe that engineers can gain from, and indeed be expected to have, basic literacy in the social sciences as part of their competence (while social scientists, conversely, need a better grasp of engineers and engineering practice, of course). In particular, opening up the decision-making process on technical issues (e.g., introducing participatory methods) calls for more insightful and communicative engineers who can interact with other stakeholders. Engineers should be able to more fully understand various subtle societal contexts regarding technology, explain available technical options for stakeholders and society, and proactively take part in public discussion. In this context, rather than inventing the best “solution” for problems on behalf of society, engineers are considered to be experts who can offer their formulation of problems, available options for society, and, if possible, solutions.

We have collaborated for over three years in developing an advanced educational program to cultivate leading engineers who have this capacity. This collaborative program (Program for Advanced Graduate Education system for nuclear science and engineering with Social scientific literacy: PAGES) has been organized under a partnership between the Nuclear Engineering Department of the University of California, Berkeley (UCBNE) and the Global COE Program “Nuclear Education and Research Initiative” (GoNERI) of the University of Tokyo; it is funded by MEXT (Ministry of Education, Culture, Sports, Science and Technology), Japan. We conducted two “summer schools” in 2009 and 2010 as trial cases of the educational program. This year, while we were preparing the third summer school focusing on HLW (high-level radioactive waste) disposal technology and society, we found ourselves faced by one of the most serious nuclear disasters in world history: the Fukushima Daiichi nuclear accident in Fukushima Prefecture, Japan.

We think of the Fukushima accident as a joint socio-technical fail-
ure. In response to this event, we decided to make our third summer school a venue for preliminary, yet multi-dimensional learning from the Fukushima accident. This “2011 Advanced Summer School of Nuclear Engineering and Management with Social-Scientific Literacy: Reflections on the Fukushima Nuclear Accident” (PAGES 2011) was held in Berkeley, CA, in the first week of August (July 31 – August 5), organized around 12 lectures and a series of facilitated discussions. It attracted 18 students from various fields and countries, principally nuclear engineering students in graduate programs in Japan and the United States, but including some social science students as well as students from other nations studying in these countries. In this paper, we will explain the concept, aim, and design of our educational program; offer a preliminary assessment of its effectiveness; introduce a couple of intriguing discussions held by participants; and discuss the program’s implications for the post-Fukushima nuclear context.

II. CONCEPT, AIM, AND DESIGN

1. Background and Motivation of the PAGES Project

An official statement of the GoNERI program framed our attempt as “the first systematic education on nuclear energy in the world … incorporating the social, liberal arts and technical subjects as they relate to nuclear utilization.” Reinforcing this perspective, special emphasis is placed in our program on integrating nuclear science and engineering with the social sciences. It is imperative that the new generation of nuclear engineers sufficiently understand societal aspects of nuclear technologies in order to serve the public good.

However, as faculty members and students in nuclear science and engineering, these individuals in many cases do not yet have sufficient command of the fundamentals of the social sciences (their domain, concepts, terminology, methodology, etc.). This limits them, we believe, in collaborating with social scientists and citizens.

Under the GoNERI program, efforts have been made to develop an innovative education program by integrating nuclear engineering and the social sciences, including a series of bi-weekly seminars and a program of field work at the Waste Isolation Pilot Plant (WIPP), at Carlsbad, New Mexico, as well as the Japanese sites of Toyo-Cho and
Rokkasho-Mura. The partners in the collaboration conducted the “2009 Advanced Summer School of Radioactive Waste Disposal with Social Scientific Literacy” in Berkeley, CA, and, together with Tokai University, Japan, the “2010 Advanced Summer School of Nuclear Engineering and Management with Social-Scientific Literacy” in Honolulu, HI.

2. Expectations for the PAGES 2011 Summer School

As summer of 2011 approached, we were preparing the third summer school, which was to focus on HLW disposal technology and society and would be held in Sweden, in collaboration with the Swedish Radiation Safety Authority (SSM). The authors of this paper (Juraku, Ahn, Nagasaki, Carson, Jensen) and Prof. Tanaka (the leader of the GoNERI program) constituted the organizing committee. We had a meeting at Stockholm in January 2011 and agreed upon an outline for the approximately 10-day program, which included a series of site visits to so-called back-end nuclear facilities in Sweden and Finland. This program was to function as an applied curriculum mainly for alumni of our past summer schools. These visits were intended to deepen students’ understanding of the societal aspects of nuclear utilization through the site observation tours, conversations with site officials and local people, and discussion with lecturers and fellow students.

However, we found our plans unsettled by one of the most serious nuclear disasters in world history: the Fukushima Daiichi nuclear accident, which was triggered by the Great East Japan Earthquake and its subsequent tsunami on March 11, 2011. The organizing committee decided that the 2011 summer school should instead focus on reflections on that shocking event (although we still hold that the importance of HLW disposal remains unchanged, or perhaps becomes even more urgent in the disaster’s aftermath). This accident raised many fundamental and controverted questions regarding the traditional approaches of nuclear engineering and its utilization in society. We believe that engineers and other experts involved in nuclear utilization need to take those questions very seriously and be responsive to criticism and concern expressed by citizens.

This decision led to a change of venue for PAGES 2011, as well as the introduction of an amended topic for the school. While we initially
considered the possibility of having the school at the campus of the Univ. of Tokyo or any other place in Japan, this option was rejected due to (among other reasons) the serious burden of a projected shortage of electricity in the summer season. We also wanted to make this school a place that enabled the participants to critically address the situation and issues involved in this accident. Considering these factors, we decided to hold the PAGES 2011 summer school at the UCB campus.

3. Aim and Design of PAGES 2011 Program

The PAGES 2011 summer school was a 5-day program that focused on the issues raised by the Fukushima Daiichi accident, in the larger context of interactions and relations between nuclear technology and society. This program was not intended to reach a single agreed-upon conclusion about the accident. Rather, we designed the program to encourage participants to develop their own philosophies, stances, and/or principles that they believed to be appropriate and responsible in the post-Fukushima nuclear context. These were to be based on the collected and confirmed technical facts on Fukushima, on social-scientific methods and approaches that enable us to think about the event more deeply and analytically, and on intensive dialogue among participants. The word “reflections” in the title of the PAGES 2011 school indicates our intention; it means that as participants we should not make comments or criticisms as outsiders, but instead should critically examine our past practices and thinking and subsequently change our assumptions, approaches, methods, and stances, from a position of open-mindedness.

We understood that this approach would be different from standard nuclear engineering curricula. In particular, we wanted to give an important role to the students themselves. We decided that the best way to implement this intention would be a combination of lectures and intensive facilitated discussions, leading to student presentations and individual written essays.

To realize this concept, we brought together 12 lecturers and 3 discussants from various fields centering on the interface of nuclear technology and society; i.e., the chemistry of radioactive nuclides in the environment, reactor physics, radiation protection, reactor design, engineering ethics, technology governance, sociology of science and technology, history of nuclear technology, and long-term energy portfolio
and nuclear policy. Table 1 is the list of lectures and lecturers.2

**Dr. Tatsujiro Suzuki (Atomic Energy Commission of Japan)**

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Each of the first four days included 2 or 3 lectures (45 minutes each). On the first day (8/1), 3 lectures on a technical analysis of the Fukushima accident were provided. Those sessions were intended to provide a common grounding in technical facts for all participants, as the basis for social-scientific discussions in following days.

On the second through fourth days (8/2 – 8/4), lecturers with deep knowledge and expertise in various social science disciplines and problem areas demonstrated social-scientific approaches that could be helpful in thinking about this complex and tragic socio-technical failure.

Stemming from these lectures, students were encouraged to join in discussion with their fellow students and lecturers. Morning discussions spanned 30 minutes, and afternoon classes included a 90-minute “reflection and discussion” slot. In these latter sessions, discussants (persons who were designated to lead the discussion; 3 post-doc researchers took this role) encouraged interaction among participants by proposing points to be explored and steering discussion as needed.

Students formed small groups (about 4 to 6 people) during the group discussion/work sessions. This grouping was undertaken by the students themselves, and was based on shared interests. Students repeatedly held discussions within the groups and formulated tentative answers to some of the questions posed by lecturers, as well as other questions they found important in the larger group discussions.

To accelerate interactions among student participants, “student session” slots were scheduled for the evenings of 8/2 and 8/3. In these sessions, UT and UCB students made oral presentations that introduced their own, often quite intensive activities after the Fukushima accident, described their thoughts regarding the event, and sought feedback from other students and lecturers.

In addition to lectures by academic researchers, we were fortunate to have Dr. Tatsujiro Suzuki, vice chairperson of the Atomic Energy Commission of Japan, as the after-dinner speaker on the evening of 8/4. His talk was intended to deepen students’ appreciation of the connection
between academic research and the policy-making process.

The four days of lectures and discussions then culminated in student presentations on 8/5 (Fri.). The self-organized student groups made presentations about their questions and answers and received feedback from lecturers and other participants. The summer school closed with a session of reflections by the lecturers and organizers and a general discussion with the student participants.

### 4. Specific Arrangements For Educational Effectiveness

To make this educational program more focused and effective, we made several concrete arrangements before, during, and after the term.
of the program:

- Student applicants for this school were required to write a short essay on the root cause of the Fukushima accident and to articulate what they wanted to gain from the summer school.
- The organizing committee asked lecturers to prepare 5-page (at most) summaries of their lectures before the school was held. They were also asked to provide questions regarding their topics that encouraged students to think about the accident more deeply. Those materials were circulated for students before the school.
- Each student was required after completing the school to submit an individual essay that described their own answers to the questions they chose to focus on, based on all of the discussions they participated in, including the concluding sessions.
- Students’ reflections on their learning experience, as well as feedback and suggestions, were sought in an open-ended questionnaire on the concluding day of the program.
- The organizing committee asked lecturers to submit their full papers (max. 10,000 words) after the completion of the school. Discussants were also asked to write a paper that summarized the main points covered in the lectures and discussions. The committee has collected these papers, and we will author our own contributions that discuss the implications of this school. These materials are planned for publication as a book.

III. RESULTS AND PRELIMINARY EVALUATION

1. Points Discussed During the Program

The PAGES 2011 program brought about very intensive and thought-provoking exchanges among the participants. Across many intriguing discussions, the following points emerged as potentially critical for post-Fukushima nuclear engineering education and societal decision-making:

- Problems centering on the social justification of nuclear utilization. In particular, utilitarian arguments – such as cost-benefit analyses – became a central point of discussion throughout the sessions. Some participants considered these justifications less compelling after the
Fukushima accident. On the other hand, others argued that cost-benefit evaluation is still reasonable and, ultimately, necessary as a form of science-based assessment.

- In parallel with the issue above, the concept of “rationality” itself was questioned in discussions by lecturers and students. Some participants argued that the role of science (and scientists or engineers) is to provide neutral and logical conclusions based on knowledge (and these individuals’ expertise), which will render societal decision-making “rational.” These participants criticized other social reactions, such as the anti-nuclear movement after the Fukushima accident, as “irrational.” However, another group of participants voiced the opinion that such social reactions embraced a different kind of “rationality” than that of technical experts. These participants argued that different types of “rationality” should be considered more intensively when society makes decisions regarding science and technology issues.

- Prof. William Kastenberg raised an issue about “Safety Culture” in the Japanese nuclear industry. He pointed out its weakness in light of the Fukushima accident and its consequences, and suggested an explanation of the roots of this weakness based on cultural and historical differences between Western and Asian societies. He illustrated the importance of individualism when considering engineering ethics. This argument triggered much discussion regarding the character of social-scientific explanation and analysis of the root cause of the Fukushima accident.

- Many participants also focused on the importance and difficulty of public and inter-expert communication during emergency situations. They described some dilemmas: timely information vs. well-confirmed information, simple and understandable explanation vs. detailed and correct explanation, controlled disclosure vs. unlimited disclosure, and so on.

As we intended, no particular conclusion was reached on these difficult issues in our school. However students reported that they conceptualized such dilemmas more sharply than they did before as a result of interactions with people who took different stances, brought different methodological perspectives, and held contradictory opinions.
2. Feedback from Participants

In their post-school feedback, many students strongly emphasized the importance of interaction with people of different backgrounds (for instance, Japanese and American) and different fields (engineering and social science). Many students mentioned a lack of time; specifically, they wanted to have more time for discussion with other students and lecturers. A number also requested more presentations by and discussions with social scientists. Some students regretted the absence of field trips, particularly as these had been included in our 2009 summer school. Students said they wanted to have such occasions to both expand their understanding and strengthen relationships with other students, as well as render their learning more concrete.

3. Preliminary Evaluation of PAGES 2011

As described above, and in accord with our aim, we were able to bring about very intensive and intriguing discussions throughout the program. Every point raised in our discussions on the lessons learned from the Fukushima accident offers an important perspective to potentially avoid similar failures in future. Not only did students gain knowledge from the lectures, they also broadened and deepened their perspectives on this terrible nuclear accident and nuclear utilization more generally through candid discussion. This summer school stimulated students’ consciousness of various socio-technical issues that must be considered by the next-generation of leading engineers. In this sense, we believe we can preliminarily evaluate this school as successful.

IV. CONCLUDING REMARKS

The Fukushima accident is not an event of the past; it is an ongoing and developing story. Our educational program development is still in its early stages. We believe it should be continued so as to supply the new generation of leading engineers with sufficient social-scientific literacy and knowledge. We consider the publication of an edited textbook as our next milestone, and are putting our collective efforts into this project.
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