Socially Responsible Engineering

Socially Responsible Engineering: Justice in Risk Management. Daniel A. Vallero and P. Aarne Vesilind
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and
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Foreword

Issues concerning ethical practices in research and technological application have been publicized in the last decade. Although these problems originally were concentrated in biological and medical science areas, problems with work done at an industrial laboratory and at a US national laboratory showed that ethical lapses occur in other disciplines. Another type of ethical issue was demonstrated in the shuttle Challenger destruction, an example of how politically-driven pressures can cause engineers to repress crucial analyses.

A great American engineer, Norman Augustine[1] wrote ''Engineers who make bad decisions often don't realize they are confronting ethical issues.'' He went on to write that ''it is important that ethics courses also deal with the pragmatic issues that confront engineers in the rough-and-tumble, everyday world in which they live and work.''[2]

This text by Vallero and Vesilind brings together two authors who have written extensively on issues that do relate to the work-day world of the engineer. Vallero, a senior engineer and environmental researcher in the Executive and Legislative Branches and an adjunct professor at Duke University, has incorporated in this text many examples of practical engineering problems. These are the strength of this text. Vesilind, a long time engineering professor at Duke University and now at Bucknell, has published many articles on the ethics and engineering. Their perspective is seen in that the dominant theme of this text is the first rule of practice from the National Society of Professional Engineers. The First Fundamental Canon is ''Engineers, in the fulfillment of their professional duties, shall hold paramount the safety, health, and welfare of the public.''[3] The many examples in the text illustrate application of this criterion.

For several decades Edward Obert was on the mechanical engineering faculty of the University of Wisconsin-Madison. He sprinkled his lecture notes with ethical guidelines. and wanted to be remembered by a quote from Socrates: ''When my sons grow up, I would ask you, my friends, to punish them if they care about anything more than virtue.''[4]

Those words are guidance for the engineering profession.

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REFERENCES AND NOTES

1. Former chairman of Lockheed Martin, former Under Secretary of the Army, and former lecturer with rank of professor at Princeton University. He is a former chairman of the National Academy of Engineering and the chair of the National Academy of Engineering Committee on Engineering Ethics and Society.

2. ''Ethics and the Second Law of Thermodynamics,'' Norman R. Augustine, *The Bridge,* Volume 32, No. 3, Fall 2002.
3. http://www.nspe.org/ethics/Code-2006-Jan.pdf
4. From the Dedication to *The Responsible Researcher: Paths and Pitfalls,* J.F. Ahearne, Sigma Xi, The Scientific Research Society, 1999.

Preface

Few technical books begin with questions of how we can be virtuous in our duties as professionals, although many engineers, planners, and scientists are concerned with what it means to be a ''good'' engineer, planner, or scientist. Most books used by technical professionals are limited to discussions of practical questions (or more correctly, questions of professional practice), and it is perfectly appropriate and absolutely essential to be concerned with concepts such as physical integrity of structures, sources and exposures to pollutants, and the applications of physics, chemistry, and biology to solve problems. But only a limited number of texts delve into the philosophical underpinnings of science and engineering professions. Of those that do, most mainly address issues in professional ethics.

One of the challenges in dealing with social issues in a way that informs and interests most engineers and other design professionals is to cover concepts and to use language familiar to a technical audience without wandering into the vernacular of the social sciences. In fact, many of us are ''compartmental'' in how we think about the world. All engineers are very interested in solving problems by applying the laws of science and the principles of mathematics. The researchers among us are equally interested in the theoretical foundations of these laws and principles. So the first division among those of us who are technical types is between basic and applied science. Next, as educated people, engineers are very interested in the other ''nonscientific''* aspects of the world around us, but that is an entirely different compartment from what we do for a living. A growing number of design professions pull all of these compartments together. They do not see the need to draw bright lines between the physical, chemical, and biological sciences and the social sciences and humanities, as long as they affect one another. In fact, we believe that there is a growing need for engineers to become more comfortable with social issues. This book is one step in that direction.

We are not naïve in thinking that all engineering students and practicing engineers will simply embrace what some may perceive to be ''soft'' subject matter.† In fact, we believe that the approaches applied to date in raising our awareness of societal issues have been woefully inadequate, especially in their seeming disregard for how engineers teach and learn. In particular, they seem to treat issues like justice as sidebars where the engineer is asked to suspend engineering realities to think about social issues. This approach is unfortunate and ignores the essence of engineering since issues like ethics and social justice are often even more mathematically challenging than ''typical'' engineering

* We use this term advisedly. In this context it distinguishes engineering and physical sciences from the social sciences and humanities. We recognize this line of distinction is frequently blurred and that rigorous adherence to the scientific method is not limited to the physical sciences.

† Vallero recalls a colleague's somewhat sarcastic contention that any study whose textbook requires more than one page to explain ''why'' it is a science is indeed *not* a science. We are a bit less strident in our viewpoint.

problems like those solved using the Bernoulli and Navier–Stokes equations, Fick's and Newton's laws, and Bohr's concept of the atom. In fact, social concepts may often be described as ''ill-posed'' and nonlinear, just as are many of the most challenging physical concepts being studied in engineering classes today. Compared to many design problems, social issues frequently have more variables, exhibit initial and boundary conditions that are extremely difficult to define, require sophisticated mathematical approaches, call for creative optimization schemes, and hardly ever have a singular solution.

Thus, the structure and tenor of this book address a profound challenge to the engineering profession—social justice—in language and concepts familiar to engineers. We do not shy away from the mathematics, although in light of the large range of engineering disciplines, all equations and notation are explained. In this way, this book is very different from most environmental justice texts. We also do not avoid discussing the intricate details of economic, sociological, and philosophical subjects. Since not all of our technical audience is familiar with these topics, we explain them in detail. This book also differs from most environmental engineering texts in that in addition to explaining the basic and applied sciences, we use case studies, examples, sidebars, and biographies to drive home important concepts.

The authors of this book are both environmental engineers. Among the other important experiences that we have in common, we have both directed the Program in Science, Technology and Human Values at Duke. As the name implies, the program calls for a new way of looking at the world. Leading such a program demands that science and engineering be approached as a social construct. This may bother those who hold that ''real science'' is unaffected by the norms and influences of the culture in which it resides. How science is conducted and who is able to conduct science are affected by culture. Some advocates erroneously argue, however, that the actual meaning of results differs. Therefore, we agree with the need for objectivity and adherence to the scientific methods prescribed by Bacon, Boyle, and other giants in the history of science, but we hold that ethics is an integral part of this construct, as is appreciation of the myriad policy and analytical approaches for studying the role of science and engineering in shaping and in being shaped by society. An essential part of an engineer's social contract is that we be trusted as professionals. Such trust must be based on both sound science and the appropriate societal application of that science.*

The dearth of virtue-related textbooks is particularly ironic for the fields of environmental science and engineering. After all, the environmentalism movement came to the fore in the 1960s, a time when Western society was rethinking its systems of values. The values long held by the ''establishment'' were being tested. Everything from capitalism to the law to politics was up for review. While Martin Luther King was leading marches in Selma and Washington, Rachel Carson was challenging the petrochemical revolution

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*Incidentally, since we mentioned Robert Boyle, we should also mention Thomas Hobbes. Boyle is recognized as one the key proponents of *a posteriori* (experimentally based) science, whereas Hobbes argued for *a priori* science, the idea that knowledge is independent of experience. Since the Renaissance, modern science has embraced Boyle's view. However, as mentioned here, Hobbes' concept of the social contract is widely held by many social theorists as an important normative force in society. According to contractarian theory, all professionals, including engineers and physicians, have a special place of trust within society. In fact, public trust is a common feature of all ''professions.''

in her famous book *Silent Spring.* Notable examples of reason and stability have emerged since these times, as codified in the Voting Rights, the Civil Rights, the National Environmental Policy Acts, as well as the successes in establishing the arsenal of federal and state environmental laws, but we have yet to formulate a consensus on which virtues are absolutely requisite for our environmental professions.

Leafing through the book, practicing professionals or students might decide that the book may not be relevant to them and their interests. Like many of us, they are less comfortable with ''soft'' considerations such as philosophy than with the physical sciences, engineering, and other ''hard'' intellectual matter. But please bear with us! The face of engineering is changing. We must remain highly competent in our application of mathematics and the natural sciences, but engineering is more than that. The engineer today and in the coming decades must adapt to a changing world. The National Academy of Engineering puts it this way:

> [O]ne thing is clear: engineering will not operate in a vacuum separate from society in 2020 any more than it does now. Both on a macro scale, where the world's natural resources will be stressed by population increases, to the micro scale, where engineers need to work in teams to be effective, consideration of social issues is central to engineering. Political and economic relations between nations and their peoples will impact engineering practice in the future, probably to a greater extent than now.*

There has been no better example of the societal responsibilities of the engineer than that demonstrated by the events that led to and followed Hurricane Katrina on the U.S. Gulf coast in 2005. Engineers were clearly part of the problem. Some of this culpability was technical malfeasance, but much of it was a failure to recognize risks beyond math and science. Justice is a big part of what engineers and scientists are all about. In fact, the audience for social justice is not only those of us immersed in either the environmental aspects (e.g., ecologists, environmental engineers, environmental scientists) or the justice considerations (e.g., lawyers, policymakers), but all engineers and most scientists. For example, a structural engineer who is designing a bridge is wise to consider not only the structural elements (e.g., stress and strain, elasticity, weight loading), but the context of the bridge in terms of what it means to the fabric of the community and whether the design is benefiting from sufficient input and participation regarding the placement, aesthetics, and flow patterns to and from the bridge. Certainly, most of the case studies we consider here and throughout the environmental justice literature are specifically ''environmental,'' such as hazardous wastes sites and landfills, but every design must consider potential justice issues.

It is interesting to contrast the role of town engineer *versus* that of engineers in a large urban bureaucracy. The town engineer may have duties that would be represented by whole departments in a large city, such as public works, transportation, housing, and environmental protection. Thus the town engineer is the only professional who can ensure that just decisions are made. That is, the engineer is the only one at the table (literally *and* figuratively) with the technical expertise and power of position to represent those

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*National Academy of Engineering, *The Engineer of 2020: Visions of Engineering in the New Century,* National Academies Press, Washington, DC, 2004.

with little or no "voice." The same goes for an engineer in a small firm who advises clients *versus* an engineer in a highly specialized job in a large firm.

In this book we begin by addressing questions that concern all of us in asking what is meant by such terms as *just science, just engineering, virtue, environmental justice,* and *environmental racism.* In the second chapter we inquire into our justification for invoking the principles of environmental justice. In the third chapter we look back at the engineering profession and consider what it means to be a professional, especially in light of such issues as ethics and justice. In Chapter 4 we delve into the question of risk from harm due to environmental effects and suggest a new paradigm for thinking about how risk should be estimated. In Chapter 5 we follow up this discussion by noting that risk assessment is merely the first step, and that action is needed to protect the public health and welfare. The sixth chapter focuses on the concept of sustainability and how this ties in with environmental justice. Finally, Chapter 7 is a discussion of how engineers interact with society, engaging the reader in various issues of applied engineering in the context of environmental issues. In this way, the engineer is given a tool kit to help to prepare for the coming expectations of the new century.

In the writing of this book, we have assumed that the reader believes that he or she, through the skill of professional engineering, has a responsibility to try to make the world a better place. To this end, we hope that our work will assist practicing engineers and engineering students alike in both choosing a career path and in gaining a deeper understanding of how engineering affects society, particularly those segments of society that are underrepresented and that have little political or economic clout. In short, this book is about how an engineer can be fair to one's clients while being fair to one's own career.

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