The Survival Imperative

Cite this article as: Stephanie J. Bird, The Survival Imperative, Science and Engineering Ethics https://doi.org/10.1007/s11948-019-00159-3

The Survival Imperative

Commentary on "Whither the university? Universities of technology and the problem of institutional purpose"

Stephanie J. Bird

Abstract

Humans are powerful and clever, and also more ignorant than they know. As a result, they too often fail to acknowledge or even recognize their limitations, and are more arrogant than humble regarding their capabilities. Education that explicitly recognizes and addresses the context of science and technology, their inherent values and ethical implications and concerns, and their problematic as well as beneficial impacts can potentially rescue the human species from itself.

Keywords: Research ethics, engineering ethics, RCR, Responsible Conduct of Research, ethics education, RRI, Responsible Research and Innovation, survival of species

Introduction: A Basic Problem

The apparent primary motivation of living things is survival, especially in service to the survival of the species. For humans, as for all species, it is essential not only to procreate, but

to pass on to the next generation the information that is necessary for survival: identification of the essentials for life (i.e., air, water, food, warmth, shelter, … joy, hope, love, a reason for carrying on), and how to procure them. In some ways, some of this information might actually be "in our DNA", but, for the most part, for humans, and perhaps other species, it is learned through both formal and informal education.

Over the last few thousand years (and especially in the last few centuries), formal education has become increasingly sophisticated, organized, and compartmentalized, and much thought has been given to describe not only what information needs to be conveyed from one generation to the next, but also why. In his thoughtful and provocative essay, "Whither the university? Universities of technology and the problem of institutional purpose", Seumas Miller (2019) provides an extended examination of the values embodied in Western institutions of higher education, how and why they have come to be what they are, and the larger implications of that evolution.

Humans as a species are clever and powerful. This has made possible impressive technological advances the short-term consequences of which are readily apparent. If negative short-term consequences outweigh positive ones, then these clever ideas and inventions are "a flash in the pan". If positive, beneficial short-term consequences outstrip negative ones, and especially if they produce significant financial gain, the benefits can encourage and spur-on further efforts in the same direction. Long-term and rare consequences are, almost by definition, not readily apparent, and often humans are ignorant of them. More to the point, positive short-term effects that provide financial gain for powerful individuals or entities tend

to discourage energetic investigation, or even recognition or acknowledgement of negative impacts.

Humans' curiosity about themselves and the universe around them fuels the vast array of research in the natural and social sciences. At the same time and not surprisingly, humans are largely ignorant of the full panoply of the information that they lack. – This is the challenge of the "unknown unknowns".[1] As examples, one need only consider the long-term environmental, ecological, climatological, and psychological effects of the enthusiastic and energetic development and adoption of technological advances such as plastics and carbon-based fuels that were unrecognized fifty years ago and are becoming evermore apparent over the last few decades. The winning combination of clever and powerful, coupled with ignorance (intentional or not), reinforces a kind of arrogant assumption regarding the limitless capacity of humans to overcome obstacles, resolve problems, and mitigate negative consequences. This combination of characteristics, clever, powerful, ignorant and arrogant, has the potential to stand in the way of species survival.

Education as a Solution

Whatever a species has learned, each new member is born as the proverbial "blank slate" and species knowledge must be taught to subsequent generations. Yet, like the proverbial cat that only jumps on a hot stove once, it is not always clear what message one should learn from one's experience, what is truly generalizable, what will endure, that is, what

[1] Donald Rumsfeld, US Secretary of Defense, 12 February 2002.

is worthy of becoming common knowledge. Science, technology, engineering, and mathematics (STEM) are, in a sense, an embodiment of the intelligence and strength of humans, and STEM has become, increasingly, a watchword in secondary and higher education, lauded as a password to the future success of both the individual and the species. Indeed, over the last fifty years, a broad liberal arts education has fallen out of favor in the US, and it is not only engineering students who voice the short-sighted complaint that breadth requirements are a poor investment of time and effort.

However, science and technology must be seen, understood, and assessed in the context of society as a whole. Although the science and engineering communities are part of society, not apart from it, to some extent, they and their investors are deaf to the concerns of the larger society. And wider society is recognizing and questioning the broad implications and impacts of STEM, in part, thanks to the thoughtful contributions of fiction and nonfiction visionaries. Rachel Carson (1962), Margaret Atwood (1985), Bill McKibben (1989) and Michael Crichton (1990) and many others have insightfully and eloquently offered cautionary views on the potential implications of a reflexive, unquestioning adoption of technology. Past generations have also provided a rich legacy of historical and philosophical perspectives (e.g., John Dewey [1922, 1927,1938], Karl Popper [1945] and Charles Lindblom [1959]).

Moreover, the challenge of recognizing and addressing long-term, rare, indirect, and potentially unforeseeable consequences has prompted not only the precautionary principle and/or precautionary approach to evaluating and regulating technology, but also a careful and explicit consideration of “technologies of hubris” versus “technologies of humility” (Jasanoff 2003), and development of a measured, thoughtful ethical framework for assessing new

technologies (van de Poel 2016; van de Poel and Robaey 2017). In addition, recent research has provided a better understanding of the processes of teaching and learning that can improve education (Bransford et al. 2000). Further, there are clear elements and characteristics of effective education in research and engineering ethics (Bird 1999, 2004; Glowinski 1993; Mumford et al. 2007, 2008; NIH 2009). This work, and heightened sensibilities, provide a wide variety of resources and a strong foundation on which members of both the STEM, and research and engineering ethics communities, can build.

Although research and engineering ethics have tended to emphasize the responsible conduct of research (RCR) in the US and social responsibility in Europe (Bird et al. 2013), both approaches are essential and, indeed, are complementary (Bird 2014; van den Hoven 2016). What is also essential is that ethics in science and engineering be specifically considered and addressed as integral to STEM education (National Academies 2017). A number of teaching programs, strategies and techniques have been developed and some are described and highlighted in this Special Issue (Boni et al. 2015; Engel-Hills et al. 2019; Mitcham and Englehardt 2016; Murphy and Gardoni 2017; Sunderland 2013; Taebi and Kastenberg 2016; van den Hoven 2016; Wang and Yan 2019).

Funding agencies are also reflecting, and responding to, societal concerns. For example, the US National Institutes of Health (NIH) has developed and implemented requirements for the education of junior researchers in the responsible conduct and reporting of research (NIH 2009), and the US National Science Foundation (NSF) also has an RCR requirement as well as a requirement that every proposal for funding must be evaluated, in part, on its broader impact on society (NSF 2017). The European Commission's program for

funding scientific research has made Responsible Research and Innovation (RRI) a main focus as well (von Schomberg 2013). In addition, ABET (formerly the Accreditation Board for Engineering and Technology) includes ethical and societal impacts criteria in evaluating engineering programs (ABET 2019).

Unfortunately, all too often, institutions and STEM faculty (1) remain unaware of these developments within the science and engineering ethics community, (2) are only minimally attentive to these requirements, or (3) choose to ignore them all together. Even twenty to thirty years after their introduction, these expectations of the funding agencies are viewed by some as, at best, unnecessary requirements being stuffed into an already full curriculum, if not obstacles to progress.

Nevertheless, there are reasons for optimism beyond the particular requirements of funding agencies and accrediting boards mentioned above. The US National Academy of Engineering's Center for Engineering Ethics and Society (CEES) continues to expand and improve the Online Ethics Center (OEC) which was initially developed by philosopher and science and engineering ethics educator Caroline Whitbeck in the 1980s (National Academy of Sciences 2019). The OEC is becoming an international resource for faculty as it continues to collect, develop and curate strategies and materials for teaching students, and colleagues, about the ethical issues associated with the practice of science and engineering, and with the application of research findings and technology. Similarly, *Science and Engineering Ethics*, an international journal founded more than twenty-five years ago as a forum for dissemination and discussion of experimental findings and the thoughtful examination of ethical concerns, ideas, assumptions, and practices associated with science and engineering has continued to

grow at an increasing rate. -- It now publishes more than four times as many papers per year as in the first years of publication, and, over the last five years, submissions from around the world have almost doubled.

Within and beyond the science and engineering communities, there is an ever-growing awareness and attention to the issues and implications of not only long-term and rare consequences, but also of substantial, indirect and potentially unforeseeable implications of developments in research, and of the application of research findings and technology. These concerns and impacts merit in-depth consideration in the context of society and culture, and extensive, explicit attention in the education of each and every generation. It is critically important that the potentially negative effects of science and technology be acknowledged and addressed along with the positive ones since both will affect the environment and influence human evolution. Otherwise, it would seem that the long-term survival of our powerful and clever species may be in doubt, and that of other species as well.

References

ABET. (2019). Criteria for accrediting engineering programs, 2019-2020. https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/#GC3 Accessed 18 November 2019.

Atwood, Margaret (1985). *The Handmaid's Tale.* McClelland and Stewart

Bird, S.J. (1999): Including ethics in graduate education in scientific research. In

Perspectives on Scholarly Misconduct in the Sciences Braxton, J.M., ed. Columbus, Ohio: Ohio State Univ. Press. pp. 174-188.

Bird, S.J. (2004). Integrating Ethics Education at All Levels: Ethics as a Core Competency. National Academy of Engineering Report on "Emerging Technologies and Ethical Issues in Engineering". Washington, DC: The National Academies Press, pp. 125-131.

Bird, S.J. (2014). Social Responsibility and Research Ethics: Not Either/Or but Both. *Professional Ethics Report,* 27 (2), 1-4. [published by American Association for the Advancement of Science, Washington, DC]

Bird, S. J., Zandvoort, H., Børsen, T., & Deneke, M. (Eds.). (2013). European perspectives on teaching social responsibility in science and engineering. *Science and Engineering Ethics, 19* (4), 1413–1594.

Boni, A,, Sastre, J.J. & Calabuig, C.(2015). Educating engineers for the public good through international internships: Evidence from a case study at Universitat Politècnica de València. *Science and Engineering Ethics* 25 (6), this issue. doi 10.1007/s11948-015-9728-z

Bransford, John D., Brown, Ann L. & Cocking, Rodney R., eds. (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: The National Academies Press, 1st edition.

Carson, Rachel. (1962). *Silent Spring*. Houghton Mifflin

Crichton, Michael. (1990). *Jurassic Park*. Alfred A. Knopf

Dewey, John (1922). *Human nature and conduct: An introduction to social psychology*. New York: Holt.

Dewey, J. (1927). *The public and its problems*. New York: Holt.

Dewey, J. (1938). *Logic, the theory of inquiry*. New York: Holt.

Engel-Hills, P., Winberg, C. and Rip, A. (2019). Ethics 'upfront': Generating an organizational framework for a new university of technology, *Science and Engineering Ethics* 25 (6), this issue. doi.org/10.1007/s11948-019-00140-0

Glowinski, Irene. (1993). How do you measure success? Benchmarks to guide evaluation of curriculum and instruction. Paper presented at "Educating for the Responsible Conduct of Research: NIH policy and other mandates," a conference organized for Public Responsibility in Medicine and Research (PRIM&R), Boston, Massachusetts.

Jasanoff, Sheila (2003). Technologies of humility: Citizen participation in governing science. *Minerva*, 41(3), 223–244.

Lindblom, Charles (1959). The science of ''muddling through''. *Public Administration Review*, 19(2), 79–88.

McKibben William E. (1989) *The End of Nature.* Anchor

Miller, Seumas (2019). Whither the university? Universities of technology and the problem of institutional purpose. *Science and Engineering Ethics* 25 (6) this issue, doi: 10.1007/s11948-019-00147-7

Mitcham, C. and Englehardt, E.E. (2016). Ethics Across the Curriculum: Prospects for Broader (and Deeper) Teaching and Learning in Research and Engineering Ethics, *Science and Engineering Ethics,* 25 (6), this issue. doi 10.1007/s11948-016-9797-7

Mumford, M. D., Connelly, M. S., Brown, R. P., Murphy, S. T., Hill, J. H., Antes, A. L., Waples, E. P., & Devenport, L. D. (2008). A sensemaking approach to ethics training for scientists: Preliminary evidence of training effectiveness. Ethics & Behavior, 18, 315-339.

Mumford, M. D., Murphy, S. T., Connelly, M. S., Hill, J. H., Antes, A. L., Brown, R. P., & Devenport, L. D. (2007). Environmental influences on ethical decision making: Climate and environmental predictors of research integrity. Ethics & Behavior, 17, 337-366.

Murphy, Colleen & Gardoni, Paolo (2017). Understanding Engineers' Responsibilities: A Prerequisite to Designing Engineering Education. Commentary on "Educating Engineers for the Public Good Through International Internships: Evidence from a Case Study at Universitat Politècnica de València". *Science and Engineering Ethics* 25 (6) this issue, doi: 10.1007/s11948-017-???

National Academies (2017) *Fostering Integrity in Research.* Washington, DC: The National Academies Press. https://www.nap.edu/catalog/21896/fostering-integrity-in-research Accessed 18 November 2019.

National Academy of Sciences (2019). Online Ethics Center. https://www.onlineethics.org/ Accessed 18 November 2019.

NIH (2009). Update on the Requirement for Instruction in the Responsible Conduct of Research. https://grants.nih.gov/grants/guide/notice-files/NOT-OD-10-019.html Accessed 17 November 2019.

NSF (2017). Important Notice 140. Training in Responsible Conduct of Research – A reminder of the NSF Requirement. https://www.nsf.gov/pubs/issuances/in140.jsp Accessed 18 November 2019.

Popper, Karl R. **(**1945). *The open society and its enemies*. London: Routledge.

Sunderland, Mary (2013). Sunderland, M. E. (2013). Using student engagement to relocate ethics to the core of the engineering curriculum. *Science and Engineering Ethics* 25 (6), this issue. doi:10.1007/s11948 -013-9444-5.

Taebi, Behnam & Kastenberg, William E. (2016). Teaching Engineering Ethics to PhD Students: A Berkeley-Delft Initiative. Commentary on "Ethics Across the Curriculum: Prospects for Broader (and Deeper) Teaching and Learning in Research and Engineering Ethics". *Science and Engineering Ethics* 25 (6), this issue, doi: 10.1007/s11948-016- 9809-7

van de Poel, Ibo (2016). An ethical framework for evaluating experimental technology. *Science and Engineering Ethics* 22(3):667–686. doi:10.1007/s11948-015-9724-3

van de Poel, Ibo & Robaey, Zoë (2017). Safe-by-design: From safety to responsibility. *Nanoethics* 11:297–306.

van den Hoven, Jeroen (2016). Ethics and the UN Sustainable Development Goals: The Case for Comprehensive Engineering. Commentary on ‘‘Using Student Engagement to Relocate Ethics to the Core of the Engineering Curriculum’’. *Science and Engineering Ethics* 25 (6) this issue, doi: 10.1007/s11948-016-9862-2

von Schomberg, Rene (2013). A vision of responsible innovation. In: R. Owen, M. Heintz and J Bessant (eds.) *Responsible Innovation*. London: John Wiley.

Wang, Qian & Yan, Ping. (2019) Development of Ethics Education in Science and Technology in Technical Universities in China. Commentary on "Ethics 'upfront': Generating an organizational framework for a new university of technology". . *Science and Engineering Ethics* 25 (6) this issue, doi: 10.1007/s11948-019-00156-6