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On "Bettering Humanity" in Science and Engineering Education.[a]

ABSTRACT:

Authors such as Krishnamany Selvan argue that "all human endeavors including engineering and science" have a single *primary* objective: "bettering humanity." They favor discussing "the history of science and measurement uncertainty." This paper respectfully disagrees and argues that "human endeavors including engineering and science" should not pursue "bettering humanity" as their *primary* objective. Instead these efforts should *first* pursue *individual* betterment. One cannot better humanity without knowing *what that means*. However, there is no one unified theory of *what* is to the betterment of humanity. Simultaneously, there is no one field (neither science, nor engineering, nor philosophy) entitled to rule univocally. Perhaps if theorists tended their own gardens, the common weal would be tended thereby.

Keywords: altruism; bettering humanity; egoism; ethics; engineering education; science education.

1. Introduction

No less a moral philosopher than Adam Smith wrote: "I have never known much good done by those who affected to trade for the public good. It is an affectation, indeed, not very common among merchants, and very few words need be employed in dissuading them from it."[1 (p.159)] In a recent article in *Science and Engineering Ethics*, Krishnasamy T. Selvan disagrees: "All human endeavors including engineering and science have, or at least ought to have, the betterment of humanity as their primary objective."[2 (p.573)] One wonders, which is it? Should one work for humanity's betterment or not?

No one would disagree with "bettering humanity" were it clear and easy. But, the devil is in the details. The devil is in Mussolini who asserted, "The state

is all embracing; outside of it no human or spiritual values can exist much less have value"[3] (p.14); in Hitler who commanded:

> It is thus necessary that the individual should come to realize that his own ego is of no importance in comparison with the existence of his nation; that the position of the individual ego is conditioned solely by the interests of the nation as a whole . . . .[4] (pp.871-872)

Dictators and demagogues have hidden much evil and tyranny in the call to "better humanity." So, one needs to be sure that any particular call does not mask such obvious dangers.

More generally, "all human endeavors including engineering and science" *should not* have, "the betterment of humanity" as their *primary* objective. Rather, like any other human practice, these activities should primarily pursue *individual* betterment. In this way, as Smith suggests, each individual intending "only his own gain, . . . is in this, as in many other cases, led by *an invisible hand* to promote an end which was no part of his intention. . . . that of the society . . . ."[1] (p.159) This is no libertarian or capitalist harangue, but an attempt to argue seriously that the distinction between pursuit of self-interest and public interest is philosophically *crucial* in science and engineering education.

2. An "Approach for Harmonizing Engineering and Science" Education.

Selvan and many others claim that a responsible *science* entails bettering humanity. "It is the attempt of this article," he charges, "to propose the topics of history of science and measurement uncertainty as being relevant in this context

for the educators of engineering and science." Of course, they are "relevant," but Selvan means that science's history and measurement uncertainty will model respect for "variety and difference."[2 (p.574)] For Selvan, a scientist must be like Philolaos who "set the earth in motion," and not like Ptolomy who scoffed at contradictions to his sense experience. Or one should be like Aristotle who "maintained that except in the realm of logic and pure mathematics, it is always possible for things to be otherwise than they are," and then like Oppenheimer whose "openness" allowed him to break away from Aristotelian dynamics.

But, what kind of hodge-podge "respect for difference" is that? More realistically, like Aristotle, one could well be a scientific hero one era and a scientific has-been the next. Selvan claims that "'the events, procedures and results that constitute the sciences have no common structure' and there are no general standards for successful research."[2 (pp.573-575)] Yet, science *does* have more or less objective "standards"--that further a deeper, subterranean and implicit historical structure and a political agenda. The scholastic church co-opted Aristotle's physics because it accorded with its theological vision; the modern military-industrial complex applauded Oppenheimer when he helped to deliver the atomic bomb and declared him a communist when he balked at delivering the vastly more powerful hydrogen bomb. Where is "bettering humanity" in all this?

> It would be desirable to incorporate a discussion of the nature and the fundamental difficulties and limitations inherent in the pursuit of science, in particular, and in all processes of thought, in general, into the teaching process. [2] (p. 577)

What would be *more* desirable is to incorporate a discussion of the nature and fundamental difficulties, limitations, and agendas inherent in the pursuit of a *value-free* science.

Selvan believes that "This openness would hopefully bring about humility and a true rational outlook. In turn, in the long run, a more humane society. . . .[2] (p.577) What is *right* with such idealism is the idea that people become more moral when they think in a logical and systematic manner about what they want and how they plan to get it in congress with their fellows' like desires. "Balanced and open inquiry" and "humility" are essential tools for achieving these desired ends, and discussions of scientific history and limitations are useful for achieving "balanced and open inquiry." What is wrong, and what is wrong with Selvan's general approach, is the idea that "a true rational outlook" could ever be reached. In other words, *the idea that one can "better humanity" assumes that someone knows univocally and unequivocally what that means*.

Many have written against the "technical fix," and, instead, support a *philosophical* approach to science and engineering education. For example, Michael McFarland argues against the "paternalistic" view "that the issues involved [in nuclear technology] are purely technical and that the public should

simply step aside and let the engineers and scientists decide them."[5] (p.163)

"'Defense in depth' bespeaks nuclear engineers' confidence that [the] scientific method, carefully applied, can permanently triumph over human fallibility."[5] (p.163)

This overconfidence is absurd, says McFarland, given the history of human hubris (to take just a small span) from the Titanic to Three Mile Island. Mark Manion and William Evan point out in *Minding the Machines* that of course *thinking* human beings will have to mind the machines.[6] Even though machines might mind themselves more efficiently (they are usually faster and more precise), human beings *have* to mind the machines minding the machines (or mind something somewhere). There is no God in the machine, there is no "intelligence" in the machine. There are only finite human intelligences each concerned to perfect her situation (and sometimes the world) as she sees it.

Selvan does not go so far as to support the "technical fix" approach to engineering and science education. He writes:

> There are several instances in the history of science that suggest that the scientific knowledge, constituted by the body of abstractions, deductions, and theories, does not always develop in a well-planned and smooth manner. Several mistakes are often committed in the process of its development and the concepts, theories and ideologies are transitory results and not time-invariant entities[2] (p.574)

And yet he also writes "science and technology, . . ." are "admittedly the most rational disciplines available today" [2] (p.576). But, they most emphatically are not. He *assumes* the importance and preeminence of science and engineering in order

for discussion of *them* in particular to lead to "bettering humanity." But these are not important for "bettering humanity" compared with philosophy (and ethics); indeed, the relative importance of science and technology is a philosophical question. The important question when asked to discuss *more* science and engineering is: what does discussing these prevent one from discussing? There is only so much time in the classroom. What is rejected when we view science and engineering as "the most rational?"

The assumption of science's and engineering's preeminence works pretty subtly, but it is ubiquitous. In their textbook *Hold Paramount; The Engineer's Responsibility to Society* (2003), Alastair Gunn and P. Aarne Vesilind query, "Why can't ethicists be as efficient as engineers?"[7] They imply that engineering is somehow more efficient than ethics. It is difficult to distinguish between the authors' own beliefs and their attempts at provocation, but they write that engineers "almost always, . . . make correct technical decisions" and that "there is always a more or less right solution to any technical problem, at any one time. This is the state of the art answer, the answer on which properly trained and experienced professionals, . . . will agree."[7 (p.32)]

In contrast, the problem with ethics "is that there is always more than one ethical perspective, more than one value, more than one set of interests, and preferences, and ethicists . . . will attach differing weights to the various ethical considerations."[7 (p.32)] So, Gunn and Vesilind imply that ethicists make few

correct ethical decisions in an area where there are rarely more or less right solutions.

A lot of engineering students agree until their prejudgments are subverted. It is simply false to say that *scientists and engineers* almost always make correct technical decisions. What exactly *is* the correct technical decision when deciding what to do with the atomic bomb, the hydrogen bomb, human cloning, or genetically modified organisms?

Almost immediately, students exclaim that these examples are unfair. They do not assume enough about science or engineering. They do not assume, that science and engineering must deal with more specific applications. But, this response is easily countered with more specific questions. What *is* the correct technical decision when trying to decide whether to put a rubber bladder in the Ford Pinto, or in deciding whether o-rings present a clear and present danger to astronauts on board the Challenger? *Even* whether to use copper wire or some alloy reflects a cost decision (hence an ethical decision--a decision about what is good or bad/right or wrong in human behavior) and not a merely "technical" decision.[b] Such practical, everyday examples are legion (they only become "exceptional"—as in these cases—when they are made badly).

Furthermore, it is a myth that there are always more or less correct technical solutions to problems in engineering or science. When it snows, I complain to my engineers about not having a "matter transporter." After all, the instantaneous transportation of matter is a science and engineering problem.

There *are* technically "right" solutions to problems in science and engineering only *when* those questions are pre-established as within the parameters of science and engineering. For example, a gas obeys the "ideal gas law" (PV=nRT) *if* one assumes that there are no intermolecular forces and collisions are perfectly elastic.[c]

But, nearly all physical laws are "ideal" in this way. Identifying X *as* a "problem in science and engineering" assumes that it is already defined and specified. So much so that authors of such constructions really carry their solution with them to their description of the problem. The whole issue is circular. They say "This is a problem of science and engineering because precise numerical methods and observational data can be applied," which is the same thing as being able to "come up with a right solution to any problem in science and engineering" so it follows that "there is always a more or less correct solution to any problem in science or engineering" as they have *defined* it.

Jump out of their narrow definitions of science and engineering to the unsettled land where matter instantly transports, space ships transcend the speed of light, and ray guns vaporize lazy students, and scientific conventionalists are at a loss.

The problem is that there is no one unified theory of *what* is to the betterment of humanity. Simultaneously, there is no one field (neither science, nor engineering, nor philosophy) entitled to rule univocally on bettering

humanity. Nor is there a single person capable of telling us univocally what "bettering humanity" means and how to do it.

One last example: In the 16th century Galileo was forced to recant at least a few of his scientific discoveries on pain of being expelled from the Church and even imprisoned. These included observation of sunspots and craters on the moon that he had seen through his newly fashioned telescope.[8] The Church Fathers argued that *they* were "bettering humanity" not Galileo. Were they? Was Galileo? Even today, the answer is not an unequivocal "yes!" either way. Pitfalls such as Galileo's trial demonstrate that science and engineering education (or science and engineering) should have nothing to do with the *primary* goal of "bettering humanity." Probably this goal should be *secondary*. If we all tend our own garden, the common weal will be tended thereby.

3. Ethical Alternatives to "Bettering Humanity"

Science and engineering continuously evolve with the hopes and aspirations of the world's societies—that is, together with ethics. Scientists and more particularly engineers live in the settled or congealed part of the world, the part that has already been reasonably established within certain boundaries that they ignore or forget. From there, they voyage to the unsettled land to gain inspiration and subject matter.

It is not the case that scientists and engineers "almost always make correct technical decisions" or that there is always a single correct decision to be made.

Yet, on the other hand, ethics is not as bleak or "relative" as some claim it to be. It is simply false to say that there are few correct ethical decisions or few correct solutions to ethical problems.

To show this, I simply write a student's name on the board (eg. Kareem) and prefix it with "I should murder" ("I should murder Kareem"). Kareem and other students usually get the point: there are certainly settled or established propositions in ethics. It is just that most everyone already knows "do not murder," "do not steal," "do not covet thy neighbor's wife," and so on. So, we ethicists spend more time coming up with reasonable criteria for blowing the whistle, or whether one owes loyalty to a company, and other controversial matters. Ethicists live in the unsettled part of the world and take frequent voyages back to the settled to apply their theories. *Whenever* one makes a decision about what is good or bad right or wrong (what is going to make one happy, and so on), one makes a decision based on some implicit ethical perspective often captured, more or less, in the work of some philosopher or other.

Engineers more than scientist live in the settled area of engineering because doing so produces commodities. They voyage into the unsettled to take risks and come up with new designs. Engineering and science are not more important than ethics, or vice versa. It is all *one world*. Engineering knowledge is "how to" knowledge ("savoir faire")—for example, how to build a bomb. Ethical knowledge is a kind of wisdom a "whether" (savoir) to drop that bomb or to

build it in the first place. They are two sides of the same coin. The philosopher Immanual Kant said, "Thoughts without content are empty, intuitions without concepts are blind."[12(A51/B75)] Similarly, engineering without ethics is dangerous; ethics without engineering is useless. Science lies in between engineering and ethics, being part technical creation and part philosophical/ hypothetical reflection.

One must see how ethics works with the practical problem of "bettering humanity." Michael McFarland asks:

> Suppose that you were aware of a group of people being "mugged" by the misuse of a certain type of technology—for example, by having a toxic waste dump placed in their town, or by being put in danger by shoddy design or construction of their automobile.[5 (p.159)]

McFarland concludes that engineers or scientists would have an obligation to prevent such "mugging." Engineers are obligated to assist others if "some fundamental right or good" is threatened, if they have the "ability to help, without damage to self and without interference with important duties owed to others," and in the "absence of other sources of help."[5(p.160)] He writes about Kitty Genovese, the Queen's woman who was stabbed to death while thirty-eight of her neighbors looked on (no one even called the police!). Neighbors failed to act because they felt isolated and helpless. They had no history of "organized social action." McFarland concludes that, analogously it therefore behooves engineers to organize socially: perhaps to join the Union of Concerned Scientists, perhaps to vocalize through vocational societies such as the Institute of Electric

and Electronic Engineers (IEEE) or the National Society of Professional Engineers (NSPE).

Yet, McFarland's article begs the essential question: why do engineers or scientists have obligations to prevent society from being "mugged" by a particular technology? Selvan's question was: why do scientists and engineers in particular have the "objective" of bettering humanity? These are similar.

The answer to the first question (McFarland's) is fairly simple, if controversial. Engineers and scientists have obligations to prevent society from being "mugged" by technology because they are *members* of that society. It is assumed as part of the "social contract" that everyone will attempt to prevent significant harm to the body politic even at some (usually small) cost to him or herself. Engineers and scientists simply have better-honed judgment and skills in discerning and dealing with particular kinds of harms. They do not have "special" ethical responsibilities. They have the same responsibilities that everyone else has, filtered through their special knowledge and expertise.

The second question (Selvan's) is much harder to answer. This is because one cannot assume that engineers and scientists have any special knowledge or expertise in "bettering humanity." Indeed, the phrase has the same looseness of sense as "creating the greatest good for the greatest number" which (on most accounts) is the job of utilitarians. I tell my students: "If you put a starving child in front of me, I know what her greatest good is. But, what is the greatest good of the average American college student? To be given A grades regardless of

merit? Of course not. Figuring out anyone's greatest good can get pretty complicated."

Yet, the first line of the NSPE "Code of Ethics," requires that engineers "Shall hold paramount the safety, health and welfare of the public in the performance of their professional duties."[9 (p.98)] This line should receive a *negative* or admonishing interpretation--that is, *do not* do anything (within reason and fairly well-formed criteria) that interferes with other people's liberty, property or other rights. Still, many in the engineering community argue that this line should be interpreted *positively*: that is, one has positive duties to help procure the safety, health and welfare of the public. For example, the code itself says that "Engineers shall be of constructive service in civic affairs."[9 (p.101)] Yet, it is just like the code not to clarify whether this means *gratuitous* public service or not.

Other authors are clearer. D. Alan Firmage argues that satisfying "an indispensable and beneficial social need" is part of the very "definition" of a profession.[10 (p.63)] These are attempts to smuggle into science and engineering a vague and un-argued for altruism. Altruism is the ethical theory that says we should seek the interests of others before ourselves and is often thought to follow from the Bible and other religious texts. My own view is that *unmodified* altruism—the idea of really putting others before *any* thought of self--is nonsensical. One always does what he thinks is in his best interest (psychological egoism) and he *should* always do what is really in his best interest

(ethical egoism). This really is not the place (or the paper) to rehearse these arguments. It is just necessary to point out how much Selvan obviates when he writes, "All human endeavors including engineering and science have, or at least ought to have, the betterment of humanity as their primary objective."[2] (p.573)

Rather, as Aristotle wrote long ago: "All things seek the good."[11] (p.1) According to Aristotle, the good for man is a life of self-actualization according to reason and virtue, where man is a *political* animal. Aristotle actually says that a man outside of society is not a man. Accordingly, community is good. If so, it would indeed follow that each individual will seek the true good of others in society *as part* of seeking her own. Individuals are led, as Smith said, by a strange sort of correspondence or "invisible hand." Hence, given the proper interpretation, and as an alternative to Selvan "All human endeavors including engineering and science" may perhaps have "the betterment of humanity as their" *secondary* "objective."

Ethics and science/engineering bear a complex relationship, the relationship of making thought practical. Practical thought bears fruit. Science and engineering often produce clearer and more ostensible dividends than philosophy and the arts: dividends such as televisions, computers, and bridges. However, science and engineering products are not themselves univocally beneficial. Science and engineering also produce or help produce war, pornographic representation, and factory labor. Vast stretches of science do not bear fruit for ages, if ever. Vast stretches of ethical thought bear fruit (rotten or

healthful) every day. How can it be said that one is more important or more efficient than the other? Only on the assumption that science and engineering are more important can one say, with Selvan, that *more* discussion of one or the other will lead to "bettering humanity."

a. Thanks are due to a few good reviewers from *Science and Engineering Ethics* including Stephanie Bird for pointing out the good in a long and unclear first draft.

b. There are some decisions in science and engineering that appear to be "nonethical" such as whether to use a test-tube or a beaker, whether to wear a white lab coat or a yellow one, and so on. These examples are purposely cooked to make no difference to practice. As a rule of thumb, however, if something makes no difference to practice, then it makes no difference to ethics; or, everything that makes a difference to practice makes a difference to ethics.

c. PV=nRT (Pressure x Volume = Number of moles x Universal gas constant x Temperature). "An ideal gas is defined as one in which all collisions between atoms or molecules are perfectly eleastic [*sic*] and in which there are no intermolecular attractive forces. One can visualize it as a collection of perfectly hard spheres which collide but which otherwise do not interact with each other" ("Ideal Gas Law." Georgia State U. 8 Mar. 2005 <http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/idegas.html>).

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