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Commentary on "Towards a New Ethos of Science or a Reform of the Institution of Science? Merton Revisited and the Prospects of Institutionalizing the Research Values of Openness and Mutual Responsiveness" by René von Schomberg.

Carl Mitcham[a]

[a] School of Philosophy, Renmin University of China, China. Humanities Arts and Social Sciences, Colorado School of Mines, Golden, CO, USA. *cmitcham@mines.edu*

The core insight of this thoughtful and provocative article is that science has become engineering and must be re-governed appropriately. Science today is as much artefact constructing as it is knowledge-producing. Certified knowledge is found through certified construction; science has become technoscience. As such, received practices of and models for governance need re-examining.

It is not possible here to address the full range of insights and questions that René von Schomberg's challenging paper puts on the table. His argument is clearly the outgrowth of years of critical reflection in the science policy trenches of the European Commission. I would wager that there's no one who has thought longer, harder, and at greater depth about these issues. I will concentrate my comments on the question concerning engineering.

Von Schomberg frames his argument as a reconsideration of Robert Merton's argument from the 1930s and 1940s in defence of four ideal norms he called the ethos of the scientific community.

Distinct but not unrelated to epistemic norms such as testability, consistency, and simplicity, Merton argued, are social, behavioural norms of sharing research results, allowing universal participation, not letting experimental goals distort the interpretation of results, and the cultivation of repeated questioning of claims by oneself and others. Historically this was a time in which the Enlightenment view of science as an unqualified dual benefit for humanity – liberating people from myth and superstition and conquering the age-old ills of disease and poverty – was still credible. Although the relationship between engineering and science was more complex than any simple application, it still served the interests of both parties to adopt the model as a reasonable approximation. Pointing to engineering and technological "applications", science could claim purity, neutrality, and indirect credit for the world-transforming benefits that came to life in the Industrial Revolution and after while absolving itself of responsibility for harms. Claiming that it was "applying" the truths of science, engineering could disguise its captivity to capitalism and the military. The naiveté of the ideology that combined scientific purity with progressive material benefit was dramatically exploded by the 1945 detonations of atomic bombs at Hiroshima and Nagasaki.

As Hans Bethe recalled his feelings after Hiroshima, "The first reaction which we had was one of fulfilment. Now it has been done. Now the work which we have been engaged in has contributed to the war. The second reaction, of course, was one of shock and horror. What have we done? What have we done? And the third reaction: It shouldn't be done again." (*Day After Trinity*, 1981) In the words of Michel Serres, "For the first time since its creation, perhaps since Galileo, science – which had always been on the side of good, on the side of technology and cures, continuously rescuing, stimulating work and health, reason and its enlightenments – begins to create real problems on the other side of the ethical universe" (Serres, 1995, p. 17).

That third reaction led to creation of multiple movements for social responsibility, first among a few nuclear physicists who had unwittingly become engineers not just of weapons of mass destruction but of power plants of catastrophic (but low probability) risk. Shortly this taking up of responsibility spread among other practitioners unwittingly engineering-infused fields such as conservation biology (see Rachel Carson) and genetics (see Asilomar Conference) – as well as among engineers themselves, although not always by engineers who publicly identified as such. In the United States opposition to the engineered (both technically and politically) War Against Vietnam intensified the issues.

When Merton analysed the emergence of social criticisms of science he focused on oppositions to the ways science as knowledge can challenge and disturb customary beliefs and is itself open to distortion when subject to manipulation by evil politics (antisemitism and racism) or stupidity (Lysenkoism). I don't think engineering is even mentioned in Merton's ethos of science papers; the word doesn't occur in the index to the collection of Merton's sociology of science papers (Merton, 1973). Yet, during the very same period, professional engineering societies in the United States were beginning a process of self-reflection that would lead to the reformulating engineering social behavioural norms in light of increasing recognition of the ways society was become an engineered and engineering world and engineers were becoming consequential actors in the political world.

Classically, in conjunction with construction norms such as efficiency, safety, and durability, engineers had assumed social obligation norms such as loyalty to employers and avoidance of conflict of interest. By the end of World War II, this engineering professional self-reflection had replaced the ethos of company loyalty with one of public safety, health, and welfare. It may be useful to recall this process, precisely because it was so ignored in the scientific community while being so relevant to what was happening in the transformation of science.

"In 1947 the Engineers Council for Professional Development (ECPD) – founded in 1932 as an organisation of organisations (not of individuals), and charged in part to develop an ethics code acceptable to its constituent engineering societies – adopted an ethics code that made it a leading duty for engineers "to interest [themselves] in public welfare" and to "have due regard for the safety of life and health of the public". Revised in 1963, 1974, and 1977, this code eventually formulated the first of seven "fundamental canons" as follows: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties".

In 1980, the educational supervising activity of the ECPD was restructured into the Accreditation Board for Engineering and Technology, now simply called ABET, to certify engineering degree programs. ABET assumed the final ECPD revision of its code, along with an extended "Suggested Guidelines for Use with the Fundamental Canons of Ethics". In this form the ABET code influenced engineering education, insofar as ABET slowly began to stress the importance of professional ethics in university engineering curricula...

A further illustration of the post-World War II emergence of the importance of social responsibility in engineering ethics was a code developed by the National Society of Professional Engineers (NSPE). Like the ECPD, one of the original objectives of the trans-disciplinary NSPE, founded 1934, was "the establishment and maintenance of high ethical standards and practices". Unlike the ECPD, which was an organisation of organisations, the NSPE is an NGO of something like 50,000 individual members, all of whom are Professional Engineers (PEs). According to its mission statement, the NSPE "promotes the ethical and competent practice of engineering, advocates licensure, and enhances the image and well-being of its members".

Although an ethics code was proposed as early as 1935, none was formally adopted until 1946, when the NSPE endorsed the new ECPD code even before the ECPD formally did so. With the 1963 revision of the ECPD code, however, the NSPE moved to create its own code. The evolution of this distinctly NSPE code led by 1981 to the adoption of a short list of "Fundamental Canons," the first of which is to "Hold paramount the safety, health and welfare of the public".
(Mitcham, 2020, p. 164-165)

Drawing on this narrative and years of teaching engineering ethics at engineering universities, I would add a fourth column to von Schomberg's matrix of governance options.

Table 2. Professional Engineering.

Normative structure of the engineering community	Engineering conduct: Employee-employer co-constructed to mesh technical power with corporate economic profit
Normative structure of the institution of engineering	Engineering values: Effectiveness efficiency; creating and protecting intellectual property (patents, trademarks, copyrights, and trade secrets)
Governance of the engineering community	Engineering codes of ethics and corporate codes of conduct (formal and informal)
Governance of the institution of engineering	Engineering-corporate-government military interfaces; technical engineering and product safety standards enforced by administrative, civil, and criminal law
Function of the engineering community	Defends professional autonomy of and promotes public appreciation of engineers and engineering
Function of the institution of engineering	Design, construction, and management of the engineered and engineering techno-lifeworld
Rewards and incentives system	Financial remuneration, professional prestige, and "existential pleasures of engineering"

Source: author elaboration based on von Schomberg paper.

Intimations of this column can be found already in a piece co-authored with von Schomberg (Mitcham & von Schomberg, 2000). Developing it here is, to some degree, simply saying something he already knows.

Each line in this new column calls for qualifying comment. As a general point, an "engineering community" does not exist with the clarity and self-consciousness of the scientific community; it is no accident that Merton does not even mention engineering and that the sociology of engineering is an orphan discourse.

It's difficult to distinguish community and institution in science – even more so in engineering. What is the difference between an institution and an organisation? Engineering is deeply embedded, even willingly in bed with and at the service of corporate and nation-state (especially military) interests. The normative structure of engineering is an echo of the normative structure of corporate interests and the social order in which the corporations exist. The autonomy of engineering is a poor cousin to the autonomy of science – which, in fact, is rather constrained. One major driver for the creation of professional engineering societies and engineering codes of ethics has been to assert some minimal independence of corporate power. Just witness the effort that has to be expended to moderate nationalism in scientific organisations.

Precisely because of its embeddedness in corporations and nation-states, the governance of engineering is naturally more legal than is the case with science. Technical standards are, in principle, established by engineers but largely under the purview of legislative, executive, and/or judicial authorities and then enforced by state-based regulatory agencies – only rarely by international regulatory agencies. Law has more traction in engineering than in science. In the neoliberal state enforcement often devolves onto corporate self-enforcement, but almost never into professional engineering enforcement. Engineering enforcement is mostly subservient to corporate rather than engineering interpretations of relevant legal standards. There are more lawyers than scientists or engineers in the U.S. Environmental Protection Agency. When engineers complain they are marginalised or professionally driven to become whistleblowers, they are seldom defended by state power. As Winston Churchill would have put it, engineers are "on tap, not on top."

Yet engineering is the "primary productive force," as Deng Xiaoping would have put it. It is not just science that has become engineering (von Schomberg's insight) but human existence today; our lifeworld is now engineered, and we cannot help but imagine ourselves in engineering terms or as engineers *manque*, though we seldom thematise as such. It's not just that science has been infused with engineering (again, von Schomberg's point) but that "application" of science takes place through engineering methods like those used to construct the engineering sciences (mechanics, statics, dynamics, thermodynamics, electronics, etc.). Engineering design methods have become operative in our own individual, liberally constructed life projects. It is not science but the engineering sciences that are the foundation of material culture.

Rewards and incentives in engineering: On top of the normal rewards of wealth and recognition, the Hegelian "master and slave" dialectic is at work in what engineer philosopher Samuel Forman (1976) celebrated as "the existential pleasures of engineering". Engineers take pleasure and satisfaction in making and constructing things that work, in making things happen, that enter the world with power. Recall Bethe's first response to Hiroshima.

Independent of all qualifications, the fourth in the column constitutes a governance option that is closer to and provides implicit commentary on the third. A fuller development of that commentary needs to be left for another occasion. However, beyond the question concerning engineering, and speculation about how the governance of engineering may have implications for thinking about the governance of science, there is the question concerning governance. The liberal attempt and tendency to replace thinking about government and nation-state power with processes of governance implicates engineering and more. "Governance" connotes an idealist or liberal effort to step away from the realities of power. When asked to explain the difference between governance and government, ChatGPT responded:

> Governance refers to the processes, systems, and practices through which decisions are made, authority is exercised, and accountability is maintained within any organisation or society. It encompasses a broader concept than government, involving multiple stakeholders and institutions.

Government refers to the formal institutions and structures through which a country or community is ruled. It includes the political authority, elected officials, and administrative organisations that exercise executive, legislative, and judicial powers.

Note the absence of references to power in the description of governance. The shift in public discourse from government talk to governance talk constitutes a typically Enlightenment effort to replace power with rational self-regulation (the cybernetically engineered system can be taken as a paradigm). It is a liberal ideal that the real experience of the governance of engineering might suggest questioning.

As I've argued elsewhere (Mitcham, 2021), the liberal science policy ideal of governance by public participation, as it has developed in response to democratic criticisms of the elitist model articulated in Vannevar Bush's *Science: The Endless Frontier* (1945), is severely weakened by mass disaffection to such participation. People who for whatever reason – too busy, too tired, too interested in other things, too much aware they don't know enough, too much want to be left alone – don't want to be involved, can easily experience attempts at persuasion or enticement into participatory governance as liberal hypocrisy. The same liberals who valorise freedom want to limit the liberty not to do so, of those who don't want to contribute to the governance of science. In light of the structural fact that they will often be "punished" by scientific interests or corporate power when they don't participate, it can seem quite reasonable to turn to authoritarian figures who promise relief.

As indicated at the beginning, von Schomberg's account of the fate of Merton's ethos of science as science becomes engineering strikes me as one of the most insightful and provocative around. Perhaps I have contributed to the provocation, if not the insight.

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