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Responses to the critics

Personal comment on the responses to "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.

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Carl Mitcham, unlike any other author, has established a comprehensive philosophy of engineering. He has made philosophy relevant for engineers and engineering relevant for philosophers. We agree that engineering should be distinguished from the sciences. The sciences and engineering have evolved asynchronously in terms of the governance of their communities and institutions. As Carl Mitcham rightly pointed out, the engineering field adopted codes of conduct emphasising responsibilities for public health and safety early on. In contrast, the sciences have consistently attempted to 'externalise' such responsibilities to civil and political bodies. Governing institutions for the sciences were established in the Western Hemisphere in the mid-19th century. However, the National Academy of Engineering in the USA was established only in 1964, and the Netherlands will inaugurate its own Academy in 2024. It is, therefore, not surprising that distinguishing the governance of the engineering community from the institutions for engineering is more complex than in the case of the sciences (with the exemption of state-controlled technology, e.g., for engine-

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ering, for the military, etc.). This disparity has long impacted higher education: In Europe, polytechnic institutions existed as separate institutions of higher education for engineers, positioned hierarchically in relation to universities. These institutions gradually merged with the university system from the 1990s onwards.

Ironically, fields within the traditional sciences are progressively evolving into areas of engineering, such as nanotechnology, bioinformatics, genetic engineering, and synthetic biology, which require distinct forms of governance. I thus welcome Carl Mitcham's extension of my table in the position paper. Mitcham warns against overly grand expectations for public participation. However, my argument is not about participation *per se*, but about orienting research missions and research policy toward socially desirable objectives. This does not necessitate direct public involvement but does require a high degree of openness and transparency within science and at the science-society interface, enabling research missions based on social collaborations with societal knowledge actors.

Mónica Edwards-Schachter raises pertinent issues regarding the commodification of scientific knowledge, the conceptualization of open science, and the selective focus on specific research values. I have argued elsewhere (von Schomberg, 2019) that while radical open science is essential, it is not sufficient for responsible research and innovation (RRI). RRI necessitates additional measures, such as the institutionalisation of anticipatory governance and value-driven innovation. The commodification of science is one of the factors that contributes to a closed, overly competitive form of science, rather than fostering progress through open collaboration. Edwards-Schachter extends my argument by providing valuable insights into the negative consequences of science's commodification.

Moreover, RRI must address market failures to enable the transformative changes required to meet the Sustainable

Development Goals (SDGs). This involves institutionalising value-driven innovation, a topic beyond the scope of our current discussion. While articulating the constitutional research value of 'openness' is necessary, it is only one, 'constitutional' research value. It is of course not the only value to effectively address the much broader issue of responsible innovation. I recognize that the Mertonian framework is inadequate for today's socio-political context and acknowledge the diverse epistemic cultures within the sciences (Sabina Leonelli also refers to this diversity). I specifically highlighted the engineering sciences because of their ambivalent attitude towards 'openness', but it may be necessary to examine other fields as well. However, this does neither affects the overall argument on governance of research missions nor the overall argument for managing research around research/scientific missions concerning societal challenges.

I also appreciate Edwards-Schachter's comments on the counterproductive ways it is implemented in current Open Access policies. The prevalent model of gold open access, where authors or their institutions pay for publication, undermines the essence of 'real' open science. It reinforces scientists' preoccupation with publishing and for higher citation rates rather than sharing knowledge and data prior to publication. Additionally, it motivates scientists to move to institutions with the most substantial budgets for this purpose, a perverse incentive creating inequities in the scientific system and among countries. This practice undermines the necessary resource-sharing among scientists to effectively preserve and constitute public goods.

I am pleased with ***Sabina Leonelli's*** response. She has significantly contributed to the field of open science (see Leonelli, 2023) both as an author and through her input in public policy. The apparent disagreement arising from her response is more about the details of how to implement open science rather than matters of principle. I based my argument on a radical concept of open science: 'open collaboration and know-

ledge sharing prior to publication', which virtually equates to "science done right". However, neither the self-governing scientific community nor the governing research institutions, such as research councils and funding organisations, wish to embrace this concept fully, let alone to take it as a basis for funding and rewarding research proposals.

The implementation of open science as a response to Covid 19, as it stands – partly voluntary, as Leonelli rightly pointed out – has been incomplete, debatable, and in some instances, probably even wrong. Nonetheless, even this imperfect approach was necessary to deliver vaccines within a short period. Business as usual would have taken a decade. We cannot rely on the voluntary and morally driven responses of an 'autonomous' scientific community as the default situation. My argument is to make the scientific community's responses independent of commendable moral initiatives by providing a different incentive system, primarily based on encouraging research behaviour irrespective of the normative assumptions scientists may hold. In the absence of such a system, I can only hope that even imperfect open science practices will address urgent societal challenges, though institutional reform of science should remain on the agenda.

Leonelli's second comment, which aims at guaranteeing the quality of scientific deliberation and the deliberation at the science-society interface, is partly addressed by her own observations. Leonelli rightly points out to the need for additional norms on top of 'openness' for deliberation, such as mechanisms to ensure the uptake of criticism (which then would 'institutionalise' mutual responsiveness). However, we cannot rely on the self-governance of the scientific community to facilitate this. For example, the statutes of the European Food Safety Authority require, in cases involving the precautionary principle, an active search by appointed experts to identify disagreements within the scientific community. They must not only 'weigh' the arguments but also engage in a

debate. They may practice this principle imperfectly, but it shows that we need responsible governing institutions to ensure this deliberation and public scrutiny to check if they actually do. The 'autonomous' scientific community will certainly not do it.

We may also need to think of other mechanisms of quality assessment inspired among other by the work of Ravetz and Funtowicz (2015), a topic I dealt with already in Von Schomberg (2007, 1992). I agree with Leonelli that this is highly desirable.

Lukas Fuchs' thoughtful comments require me to be more precise about the nature of the missions. My preoccupation with providing 'directionality' to research and innovation may have given the impression that the governance of the scientific community should be entirely devoted to societal-challenge-based missions. I must acknowledge that addressing scientific challenges remains a crucial function of the scientific community. Nonetheless, these purely scientific challenges can also be governed through research missions with the identical incentives for research behaviour as research missions addressing societal challenges. (e.g. early knowledge sharing prior to publication and open collaboration). The radical open science rationale of open collaboration and early knowledge sharing is the foundation of successful, globally collaborative, networked (pure) science. The Nobel Prize-winning article that empirically confirmed Einstein's claim of the existence of gravitational waves was co-authored by 1,000 individuals. Open science requires the input of all relevant knowledge actors, although some missions can certainly rely solely on knowledge actors within the sciences.

The functional differentiation of science, politics, economy, and the legal system in complex societies, as thematised by Luhmann, should not be abandoned by blurring the distinction between politics and science. Politics should not 'steer' or politicise science; hence the proposal to establish co-responsibility for

giving direction to science and innovation at specific science-society interfaces, such as research councils and technology assessment offices. This also applies to purely scientific research missions. The public funding of these missions also requires legitimation[1]. Purely scientific endeavours are hardly ever fully detached from societal challenges, as the European Research Council's funding of 'Frontier' science demonstrates. However, research funding and governance should not be reduced to merely serving the plurality of funding needs within the scientific community (e.g., fundamental research, societal challenge-based research, industrial research, etc.) but should also address the governance of the science system in terms of productivity, effective resource sharing, and delivering on socially desirable outcomes. The current funding of science undermines the productivity of the science system (for details, see von Schomberg, 2019).

The establishment of co-responsibility to govern both the institution of science (through science-society interfaces) and the community of science (through open collaboration among knowledge actors within science and society) cannot be equated with the politicisation of science. 'Openness', both as an institutional value of science and democracy, provides a procedural basis for directing science in a deliberative democracy. It should also guarantee full transparency of these interfaces.

This brings me to ***Alfred Nordmann's*** central claim that I conflate 'openness' within science with 'openness' in a democracy. This was not the basis of my argument. I must clarify that 'openness' in science serves the institutionalised process of cooperative truth-finding, while 'openness' in a democracy aims to optimise civic participation in social-political agenda-setting and decision-making. In both cases, openness is an institutional value that relies on incentivised scientific and civic virtues rather than enforcement or codes of conduct.

The institutionalised cooperative truth-finding in science does not imply

[1] My 'model' of research funding involves funding based on missions that are rooted in open collaboration, both within science and beyond academia, involving other knowledge actors. Employers of scientists should incentivise research behaviours that promote open collaboration and early knowledge/data sharing. The evaluation of researchers should be based on the quality of their contributions to these missions. However, this model cannot encompass all types of research. For instance, authors of monographs in the humanities may not fit into this framework.

that science produces Mertonian 'certified knowledge' or that it holds the exclusive authority to inform politics. I even argue that science does not have the sole authority to determine the goals of its own truth-finding process. For effective knowledge production in addressing societal challenges, we require consensual knowledge (as long as the consensus lasts) and consensual directionality in science and innovation. This can be achieved through social collaboration with knowledge actors both within and beyond academia and by strengthening the governance of science through science-society interfaces. This approach neither conflates nor undermines the cooperative truth-finding process, as long as we maintain the distinct institutional values of openness in both science and democracy.

Social collaboration with a variety of knowledge-actors is not identical to citizen science, although the outputs of citizen science should be included in broader deliberations on scientific findings within the science-society interface. I am puzzled by Alfred Nordmann's claim that "He does not appear to fully acknowledge that the values of Mertonian science simply are not made to provide orientation for post-academic 'open science'." I believe that this is a misreading of my text. The table I provided demonstrates that my position on both the normative structure and functions of the scientific community and the institution of science is a revision of the Mertonian position. It is not only a revision of Merton's value of openness but also the provision of a new governance framework fit for the contemporary situation.

My explanation of the emergence of an ever-dominating 'engineering perspective' in the sciences shows that issues of responsibility are becoming integrated into science, counter to the Mertonian norm of disinterestedness. Moreover, I aimed to demonstrate that Merton's original incentive for originality, combined with his norm of communism (openness to and communality of know-ledge sources), has lost its function. Radical open science requires virtually instant

knowledge sharing prior to publication, thereby abandoning the priority for originality (and thus giving up on the possibility of 'original' publications) in favour of open collaboration. My position, therefore, differs from earlier attempts to revise Merton, such as those by Nowotny, who still hangs on to 'originality' and at the same time seeks to identify consensus of cooperative truth finding process across sections of society with the production of 'robust' knowledge. The latter would indeed conflate the science/society differentiation and even mix evaluative criteria for scientific truth-finding with empirical issues of consensus formation in society.

I disagree with Alfred Nordmann's diagnosis of the current situation. I claim, on one hand, that the traditional cooperative truth-finding process in science is corrupted by an overly competitive and closed system, and by issues such as the commodification of science. On the other hand, I argue that we required interventions from research policy to open up science to deliver on vaccines. The case of COVID-19 was not an ideal example of open science at work, but it was just enough to succeed once. Hence, my preoccupation is with further opening up science – COVID-19 was a small step, but we need to take several more.

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