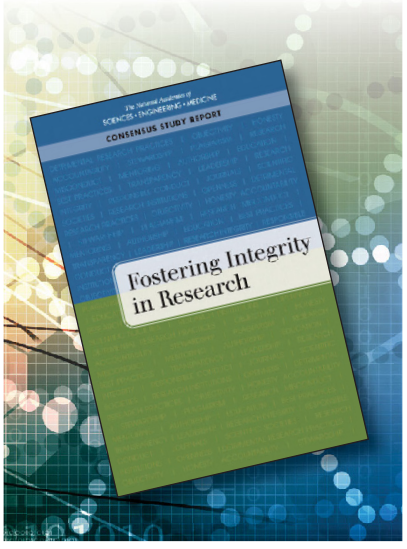
US National Academies report on integrity in science

Integrity within research is essential to ensure the quality of scientific results, and is considered a central tenet of a reputable research program. The scientific enterprise is largely self-policing with respect to integrity and quality of research through the use of expert reviewers, the practice of publishing retractions when necessary, and the detrimental consequences to one's career if research misconduct is discovered. But despite these safeguards, concerns about integrity, transparency, and reproducibility in scientific research have recently been voiced within, and outside of, the scientific community. In an attempt to address these concerns, the US National Academies of Sciences, Engineering, and Medicine (Academies) have embarked on three studies.

Completed in April 2017, the Academies *Fostering Integrity in Research* concludes, "While the research enterprise is not broken, it faces serious challenges in creating the appropriate conditions to foster and sustain the highest standards of integrity." The report points out that the research environment is constantly changing with growth in both size and scope, greater interest and input from policymakers, the application of new regulatory standards, expanding public–private research partnerships, globalization of the research enterprise, increasing dependence on information technology in research, and the shift in the media toward rapid dissemination of important results and/or controversies. The report also notes both the rise of "predatory" journals (publications that conduct minimal or no peer reviews and charge authors large publication fees) and a significant increase in the number of journal articles retracted due to research misconduct.



In addition, the report cites evidence of issues with reproducibility over a range of fields and attributes these issues to differences in research processes or procedures, research misconduct, and detrimental research practices. Research misconduct was defined in a 1992 Academies report titled *Responsible Science* as "fabrication, falsification, or plagiarism in proposing, performing, or reporting research." *Fostering Integrity in Research* endorses this definition and further defines detrimental research practice as any practice that has been considered "questionable" until now, including behaviors like misleading use of statistics and failure to retain research data. The report also notes that detrimental research practices are not restricted to an individual, but also include "irresponsible or abusive actions by research institutions and journals."

"The pressure to falsify, rush to publish, or publish unrefereed results is generally lower in materials research than other fields I've observed," says Alan J. Hurd, executive advisor at Los Alamos National Laboratory and former president of the Materials Research Society (MRS). "Even Nobel-quality work in materials does not generally have the public or media pressure that leads to problems … our issues [in materials research] seem to arise out of professional competition pressure," Hurd adds.

"The fact that individuals or groups of scientists lack integrity, or that the scientific process has been deliberately obscured in some cases, or that many published results are fundamentally irreproducible, are not political problems, nor do they have political solutions," says Shefford P. Baker, associate professor of materials science and engineering at Cornell University and also former president of MRS. Rather, Baker believes these problems arise from "well-meaning but perverse and corrupting incentives" within the scientific enterprise, and are the "result of a very human failure to maintain the culture and standards required for dispassionate, accurate scientific inquiry."

Baker also points out that research integrity has always been a priority within both the materials community and the broader scientific community. "Issues are being raised on objective grounds by practicing scientists," Baker says, which is evidence that the scientific community is both aware of, and attempting to address, these issues. Hurd agrees that those he characterizes as "intrepid doubters" within the community have the best chances of identifying questionable or falsified scientific results. A case in point occurred in 2002, when researchers noticed anomalies in published articles of Jan Hendrick Schön's work on single-molecule semiconductors, which he conducted at Lucent Technologies/Bell Labs. When the researchers brought their concerns to the company, an investigation ensued that found scientific misconduct in 16 out of 24 of the allegations (see *MRS Bull.* **27** (11), 834 [2002]). The Academies report similarly places the responsibility of addressing its own integrity issues on the scientific community, making 11 recommendations to improve the strategies and practices used to support and promote integrity in research environments.

The first recommendation made within the report is for all those within the scientific research enterprise (individuals, research institutions, federal agencies, scientific societies, and journals), to "better align the realities of research with its values and ideals." The report specifically highlights the responsibility of research institutions in creating and maintaining a culture of integrity within research, as

well as taking an active role in monitoring, investigating, and addressing issues related to research misconduct. Individuals, research institutions, and research sponsors are charged with developing educational programs that support research integrity, leveraging collaborative partnerships to share best practices around promoting integrity in research.

The report also calls for institutional and federal protection for whistleblowers; for enough information to be made available (during or shortly after publication) for a "person knowledgeable about the field and its techniques to reproduce reported results"; for funding to be allocated to ensure the availability of data and code needed to replicate published research; for disclosure of all statistical tests (including negative results) to become routine and encouraged by sponsors, institutions, and journals; and for public and private research sponsors to fund and conduct research that assesses the research culture and develop steps to address environment-related research misconduct and/or detrimental research practices. In addition, the establishment of an independent, nonprofit Research Integrity Advisory Board is recommended to provide support for all members of the scientific research enterprise by sharing expertise and methods for responding to current and future challenges.

Scientific societies and journals are specifically called out within the report to play a larger role in promoting integrity in research. One of the recommendations is for societies and journals to develop and strictly maintain clear authorship standards that designate only individuals that have made a "significant intellectual contribution" as authors. In addition, societies and journals are charged with providing identification for at least one author that assumes responsibility for the entirety of the work and requiring disclosure of contributions made by each author. Lastly, the report calls on societies and journals to explicitly specify that gift or honorary authorship, coercive authorship, ghost authorship, and omitting authors that have met the authorship standards are unacceptable practices.

"MRS has long placed an emphasis on research integrity and authorship practices in its publication policies," says Eileen M. Kiley, MRS Director of Communications. In fact, MRS has a long-standing policy on publication ethics that, as Kiley points out, already fulfills several of the recommendations made by the Academies report. Specifically, the policy calls for the results of research to be "recorded and maintained in a form that allows analysis and review, both by collaborators before publication and by other scientists, for a reasonable period after publication." In addition, the policy explicitly defines authorship standards that limit authors to those who "have made a significant scientific contribution to the concept, design, execution, or interpretation of the research study," and outlines the role of collaborators and co-authors to ensure responsibility and contributions are appropriately assigned. Baker, who is also the chair of the MRS Publications Committee, sums up MRS support for integrity in science saying, "The editors of all MRS journals, along with the staff at MRS Headquarters and our publishing partners at Cambridge University Press work diligently to ensure the highest possible standards."

The two additional ongoing Academies studies are investigating the challenges and benefits of open science (free public access to the results of scientific research) and exploring the issues of reproducibility and replication in science.

Jennifer A. Nekuda Malik

EU aviation and shipping face big challenges in reducing environmental impact

A massive shift in innovation, consumer behavior, and utilization of more ambitious green technologies to power aircraft and seafaring cargo ships will be crucial to reducing their long-term carbon footprint. A European Environment Agency (EEA) report says incremental measures such as improving fuel efficiency to cut emissions will not be enough for the aviation and shipping sectors to meet European greenhouse gas emissions and sustainability targets.

Aviation and shipping are the focus of the latest EEA "Transport and Environment Reporting Mechanism (TERM)" report published recently. The two sectors have come under increased scrutiny over their rising emissions and how they can meet EU decarbonization goals.

By 2050, global aviation and shipping together are anticipated to contribute almost 40% of global carbon dioxide emissions unless further mitigation actions are taken. The report notes that in many ways the sectors are locked into established ways of operating, which can be difficult to change. For example, past investments in conventional airport and seaport infrastructure can delay the uptake of more sustainable technologies and opportunities to encourage alternative cleaner modes of transport like rail, for shorter trips. Similarly, the long lifespan of airplanes and vessels can hamper a faster shift to cleaner technologies. Other hurdles to be overcome include the lack of research on cleaner fuels for both aircraft and ships as well as the costs involved in producing them.

The TERM report stresses that governments have a key role to play by supporting investment in research, product standards, and subsidies for new emerging technologies, and to spur the sharing of data and information on the viability of new technologies. Efforts to promote debate on sustainable travel and consumer behavior and changes to lifestyles and transport habits can also help in the long term to reduce carbon emissions and other impacts associated with aviation and shipping. □

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