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Editor's Journal

Slow Science, Fast Science

Science is moving fast right now. The novel coronavirus pandemic has created the conditions for rapid knowledge generation: about the virus itself, its behavior in individual humans and societies, the social interventions necessary to slow its transmission and hopefully stop it, and technological innovations necessary for testing, diagnosing, preventing infection, and hopefully inoculating against it. New questions continually challenge the existing state of knowledge. (Why are mortality rates so much higher in Italy than in Germany? When do which types of masks make a difference?) Continual feedbacks between research and application allow rapid testing and validation of what is being learned. (How well are epidemiological models predicting disease transmission? Are different levels of social distancing leading to discernibly different infection rates?) By the time you read this, many new and different questions will emerge, and along with them, much new knowledge.

But is fast science always a good thing? In the Spring *Issues* Interview, editor William Kearney asked Jennifer Doudna about this. Doudna, of course, is a codiscoverer of the CRISPR/Cas9 gene-editing technology. This is the tool that scientist He Jiankui used to edit the embryos of twin girls to try to prevent them from contracting HIV, an experiment that has been almost

universally condemned as unethical and that has resulted in a three-year prison term for He. As Doudna makes clear, here is a case of science moving too fast, too far ahead of the social and ethical deliberations about whether such heritable interventions ought to be permitted in the first place, not to mention in the complete absence of any ethical oversight.

He Jiankui announced the results of his experiment at an international scientific meeting; he thought he was pushing the boundaries of science in ways that would bring him the sort of recognition that many ambitious scientists seek. As my Arizona State University colleague Ben Hurlbut argued in a recent article in *Perspectives in Biology and Medicine*, He's transgressions can't be understood simply as the acts of a rogue scientist—they must also be seen as an outgrowth of a research system that rewards competition, and thus speed, above all other considerations.

The widely covered He episode is one indicator of deeper, longer-term changes in science. In the third article of our series commemorating the 75th anniversary of *Science*, *the Endless Frontier*, Stephen Turner and Daryl Chubin argue that changing incentives and norms in academic science since World War II have led inexorably away from a system that valued patient, long-term inquiry focused on quality and creativity, toward a system driven by relentless competition,

grantsmanship, and productivity metrics—a system where fast science wins the day, not good science. They view these changes as a consequence of science's institutional evolution, from a relatively small, homogeneous, insular community to a national-scale endeavor justified by the promise of social benefit—a promise necessary to assure continued public funding. And they wonder about the costs to science—and to society—of trade-offs between speed and quality.

These trade-offs come into sharper relief when specific cases are considered. Agricultural research in support of international development would seem to be a science that called for as much speed as possible. But in their textured portrayal of the international agricultural research scene, Marci Baranski and Mary Ollenburger show how the quest for standardized crop varieties, which has been a central focus for scientists since the Green Revolution, often fails to benefit the millions of smallholder farmers who are, to this day, a critical part of the food system and economy of many lower-income nations. The type of science often best suited to these farmers' needs is place-based, collaborative, and necessarily slower than research using tightly controlled field trials. But this is not the type of science that attracts major philanthropic or government funding; nor does it yield the rapidly publishable results that scientists need for professional advancement.

Baranski and Ollenburger conclude by wondering if the institutional changes necessary to incentivize slower, more socially beneficial science are possible in the current research system. David Hart and Linda Silka in their article show that such changes truly are possible—at least at the scale of a single university—but that it takes vision, persistence, forbearance, and risk-taking. They tell a story of long-term, shared commitment by faculty scientists at the University of Maine to conducting research that directly benefits the citizens of that state. This means slow science that builds on strong, trusting social networks—among scientists in many disciplines, and with outside stakeholders from across society. It's also a story of how the incentives of the publish-or-perish culture

can be overcome by harnessing the underlying desire of many academic scientists to contribute to making a better world.

Each of these articles is telling us that the institutional arrangements for science need to allow space for things to slow down—that there are considerable costs to not doing so, not just scientific costs, but human and moral costs too. Yet it also has become almost impossible to avoid clichés when talking about the pace of change in the world right now, change that, as both the coronavirus pandemic and the He Jiankui episode make clear in their very different ways, is far beyond society's ability to control. Slow down? Really?

A historical perspective may help put today's challenges in context. Ken Fulton and Marcia McNutt's appreciation of the late Frank Press, former National Academy of Sciences president (and, among many other things, founder of this magazine), reminds us of both the existential insecurities of the early nuclear age and the capacity of an individual scientist and institutional leader to help counter those insecurities. Our other articles remind us that the challenges society faces are inspiring a formidable array of possibilities for the future: The almost pastoral notion of science fairs, reinvented to inspire the widest array of K–12 students. Postdocs, recognized as a key intervention point for empowering minority scientists. Public universities, redesigned as drivers of scientific and social progress. The state of California, inventing a viable path to a zero-carbon economy. The nation of Australia, navigating the science policy opportunities and complexities of global science.

And our special mix of constructive argument in our Forum section, critical assessment in our Books section, and art both thought-provoking and beautiful throughout.

So slow down for a bit, and take in the richness and possibilities on offer. They don't promise a cure for pandemics, but they tell us that the infrastructure of ideas and institutions necessary for responding to an uncertain, challenging future is very much under development. Such a work-in-progress is probably the most we can ever ask for.