14 Introduction: Reformers

The imperative to innovate is as much about reform as it is novelty. Champions of innovation assure us that the challenges of the twenty-first century—including hunger, climate change, and inequality—are not unstoppable forces. They assert that with the right expertise and the right models, these global problems are solvable. The message is personal and human-centered: in a risky and uncertain world, we all are empowered to enact change.

However, as the critics in the previous section demonstrate, the progressive ideal of innovation can be naively optimistic and even pernicious. Fear rather than aspiration often drives calls to innovate: we must "change or die!" lest we fall behind as individuals, companies, communities, and nation-states.[1] The innovation economy systematically neglects large segments of the population and ignores necessary infrastructures. As innovators tackle existing problems, they create new ones. Even true believers must admit that replicating and sustaining innovation is difficult; initiatives rise and decline, and models that work in one context may not in another.

Despite conflicting visions, one core idea unites both champions and critics of innovation: for both camps, innovation is about *change*. Reforming the world at large is the central goal driving the innovator imperative. Bringing attention to possible areas of reform—how innovators are recruited, trained, and deployed—is the goal of many of its critics. Is there common ground in these different visions of reform? If so, how might that reform work in practice?

This section assembles reformers who are reflective about innovation's problems but still optimistic about its potential for social change.

Contributors include educators who build online communities for children, historians who teach future entrepreneurs, feminist technologists who remake workplace cultures, and ethnographers who engage with laboratory scientists. These reformers grapple with the innovator imperative by combining the "How might we?" mentality of innovation's champions with the "Why?" questions of its critics. They ask: *How should we* prepare generations of innovators in the classroom, workplace, and laboratory?

A controversial feature of the innovator imperative is its extension into the education of young children. Champions of innovation argue that creativity is a vital life skill (McManus and MacDonald, chapter 4) and that exposure to innovation in childhood has a causal effect on a child's propensity to become an innovator.[2] Many advocates, however, decry that high-stakes testing, one-size-fits-all curricula, and underfunded public schools rob children of their inherent creativity.[3] As a remedy, they create informal STEM initiatives, including hands-on science centers, maker spaces, and after-school robotics clubs.[4] But these programs are not equally distributed either economically or geographically, they can perpetuate the fear that the nation's children are falling behind, and many are tied to for-profit schemes. Educational reformers ask: *How should we* nurture children's creative expression amid the standardization and corporatization of STEM education?

In chapter 15, "Designing Learning Environments That Engage Young People as Creators," MIT Media Lab researcher Natalie Rusk explains how she introduces millions of children to "playful invention." Rusk describes two related projects from the lab's Lifelong Kindergarten Group: the Computer Clubhouse, a global network of after-school sites that serve 20,000 underprivileged youth in twenty countries; and Scratch, a visual programming language and online community with 21 million users that enables kids to create multimedia projects by snapping together colorful blocks of code.[5] Both are intentional spaces where children "learn by designing," "follow their interests," "build a community," and "foster respect and trust."[6]

Rusk and her colleagues prioritize values of care (Russell and Vinsel, chapter 13) in the design and operation of their initiatives. They codesign their programs with the children they serve, they emphasize peer community-building, and they seek to avoid technocentrism. However, these values sometimes stand in tension with their programs' focus on digital tools

and coding skills. Moreover, initiatives that began as opportunities for self-discovery now overlap with the workforce goals of the innovator imperative. Indeed, while Computer Clubhouses and Scratch are nonprofit endeavors, they are underwritten by Intel and Best Buy. More fundamentally, how young is too young to encourage a child to be innovative?[7]

Colleges and universities are especially heated sites of debate regarding the training of innovators. Innovation experts propose new pedagogical and institutional models to upend what they view as an ineffective educational system. The University Innovation Fellows program (chapter 3), and the NSF's I-Corps (chapter 5), for example, imply that traditional academic approaches exert a stifling influence on would-be entrepreneurs and innovators. Yet many contributors in this volume demonstrate how scholarly inquiry better captures how innovation happens in practice. Given the tensions between learning through action and critical inquiry, *how should* universities train engineers and entrepreneurs?

In chapter 16, "Using the Past to Make Innovators," historian W. Bernard Carlson describes how engaging with history improves the education of future engineers. In the University of Virginia's Engineering and Society program, Carlson integrates empirical patterns from his research on Thomas Edison, Alexander Graham Bell, and Nikola Tesla into the engineering classroom. Working against misperceptions that invention is a "mysterious, unknowable activity," he helps students recognize the cognitive, technological, and sociological processes of innovation. As Carlson teaches aspiring innovators through a combination of scholarly inquiry and hands-on activities, students both analyze entrepreneurial networks (Feldman, chapter 6) and practice customer discovery (Arkilic, chapter 5).

Critical inquiry into the past may seem incompatible with the pursuit of novelty, but Carlson demonstrates how students can benefit from the practical application of history (Hintz, chapter 10). He argues that hackathons and other forms of experiential learning will only be effective if they rest upon a solid foundation of critical scholarship on the theory and practice of innovation. However, Sebastian Pfotenhauer (chapter 11) would remind Carlson that his theoretical model of innovation will inevitably mutate in practice. Moreover, Andrew L. Russell and Lee Vinsel (chapter 13) would argue that the University of Virginia misleads its engineering students by ignoring maintenance and focusing so intensely on invention, entrepreneurship, and commercialization.

While debates about the nuances of innovator training persist, participation in these initiatives remains unequally distributed. As numerous contributors in part I demonstrate, jobs in the innovation economy can lead to fulfilling careers and financial success. However, as Lisa Cook observes in part II (chapter 12), women and minorities struggle to access STEM education and careers. This disparity is a problem for everyone.[8] But closing the "innovation gap" requires more than just diagnosing and balancing workplace demographics; it requires changing institutional cultures and practices. So *how should we* eliminate prejudices in the workplace and improve innovation's outcomes through diversity?

In chapter 17, "Confronting the Absence of Women in Technology Innovation," Lucinda M. Sanders and Catherine Ashcraft describe their efforts to address women's systematic underrepresentation in innovation. In 2004, they founded the National Center for Women and Information Technology (NCWIT) to "significantly increase women's meaningful participation in computing." From the outset, they recognized that it would be insufficient to simply "add women to the pot and stir." Rather, they employ cognitive psychology and feminist theory to identify unconscious biases and structural barriers that reinforce women's absence in the innovation economy. They then utilize this analysis to help universities and high-tech companies implement actionable practices such as equitable recruiting and mentorship programs.

NCWIT's theoretically informed interventions offer a programmatic response to misogyny, sexual harassment, and assault in the workplace.[9] NCWIT advises major high-tech firms—including Apple, Microsoft, Google, Intel, and Facebook—that have some of the most egregious gender and diversity records in the IT industry.[10] But these firms are also NCWIT's underwriting sponsors; while this corporate patronage may represent an earnest attempt to improve, NCWIT must guard against being co-opted by its sponsors' interests.[11] Another concern is the glacial pace of change in the technical professions. A 2017 study of patentees, for example, found that at the present rate, the slowly declining gender gap in innovation will take 118 years to close.[12]

As reformers promote inclusiveness in innovation, they also question what innovators are actually *doing*. Champions of innovation pursue emerging technologies such as gene editing, artificial intelligence, and the internet of things with the conviction that these advances bring important social

benefits. But all innovations come with intended and unintended costs that most scientists and engineers are ill-equipped to address in their daily work.[13] Also, the broader public typically only can engage with new technologies once they have already been developed, making it difficult to alter their trajectory.[14] So *how should we* account for the costs, benefits, and ethical dimensions of new innovations, from idea to implementation?

In chapter 18, "Making Responsible Innovators," Erik Fisher, David Guston, and Brenda Trinidad offer a model for shaping the moral vision of researchers in training. At Arizona State University's School for the Future of Innovation in Society, ethnographers embed themselves in the laboratories of scientists and engineers who work on innovations with high uncertainty and potentially significant social impact. The humanists who conduct this Socio-Technical Integration Research (STIR) encourage self-reflection by observing scientists and asking them a series of practical and philosophical questions across the research and development process.

According to Fisher, Guston, and Trinidad, "responsible innovation" challenges scientists and engineers to consider the social implications of their innovations and to alter their research practices. Science and technology studies (STS) scholars working alongside scientists and engineers impart their disciplinary knowledge, equipping these researchers to reflexively question their work. Yet such "midstream modulations" may be overwhelmed by the scale of the innovator imperative. These ethical interventions may already be too late; adding "responsible" as a modifier signals that innovation has come to mean the opposite (Godin, chapter 9).

Participating critically from inside the innovation enterprise, contributors in this section examine the value and the shortcomings of the innovator imperative. These hybrid experts have academic research backgrounds but often take on the role of practitioners. They use their expertise in disciplines such as child development, history, gender studies, and ethnography to critique, redefine, and reshape the image and practices of innovators.

The hybrid identities of these reformers are a source of inherent tension in their work. For one, the reformers pursue their efforts at elite universities and in consultation with high-tech firms. These reformist projects are only possible given the academic freedom and financial resources their positions provide. Similarly, interdisciplinary STS programs have always had a dependent and precarious relationship with the pro-innovation institutions that

support them, requiring constant rejustification for their survival. Because of the reformers' reliance on corporate grants and consulting contracts, there is always the risk of a special interest's influence. As a result, we might ask: Are these interventions making a difference, or are they merely adding an ethical gloss to the imperative they purport to reform?

Overall, these reformers chart a compromise between the champions' optimism and the critics' skepticism about innovation as a source of social change. As national efforts to cultivate innovators grow, the contributors profiled here seek alternative approaches to who those innovators are, what problems they address, and which methods they employ.

Notes

1. Matthew Wisnioski, "'Change or Die!': The History of the Innovator's Aphorism," *Atlantic*, 12 December 2012, https://www.theatlantic.com/technology/archive/2012/12/change-or-die-the-history-of-the-innovators-aphorism/266191/.

2. Alex Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen, "Who Becomes an Inventor in America? The Importance of Exposure to Innovation," NBER working paper no. 24062, December 2017, http://www.nber.org/papers/w24062.pdf, 2–3.

3. A host of books call for an overhaul of school systems to better train innovators. See Margaret Honey and David E. Kanter, *Design, Make, Play: Growing the Next Generation of STEM Innovators* (New York: Routledge, 2013); Ken Robinson and Lou Aronica, *Creative Schools: The Grassroots Revolution That's Transforming Education* (New York: Viking Penguin, 2015); Tony Wagner and Ted Dintersmith, *Most Likely to Succeed: Preparing Our Kids for the Innovation Era* (New York: Scribner, 2015).

4. Marilyn Fenichel and Heidi A. Schweingruber, *Surrounded by Science: Learning Science in Informal Environments* (Washington, DC: National Academies Press, 2010); Jacie Maslyk, *STEAM Makers: Fostering Creativity and Innovation in Your Elementary Classroom* (Thousand Oaks, CA: Corwin, 2016); Colleen Graves, Aaron Graves, and Diana L. Rendina, *Challenge-Based Learning in the School Library Makerspace* (Santa Barbara, CA: Libraries Unlimited, 2017).

5. Mitchel Resnick, *Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play* (Cambridge, MA: MIT Press, 2017).

6. "Learning Model," Clubhouse Network, accessed 3 May 2018, http://www.computerclubhouse.org/model.

7. Christopher Mims, "How Young Is Too Young to Learn to Code?" *MIT Technology Review*, 26 February 2012, https://www.technologyreview.com/s/427064/how-young-is-too-young-to-learn-to-code/.

8. A growing body of evidence suggests that teams with racial and gender diversity are associated with greater sales revenue, market share, profits, customer satisfaction, and worker productivity. Scott E. Page, *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools and Societies* (Princeton, NJ: Princeton University Press, 2008); Cedric Herring, "Does Diversity Pay? Race, Gender, and the Business Case for Diversity," *American Sociological Review* 74, no. 2 (2009): 208–224.

9. NCWIT's work is more important than ever. Between 2015 and 2018, as this volume was taking shape, hundreds of courageous women (and a few men) came forward as part of the #MeToo movement to reveal serious cases of sexual harassment and assault, resulting in the firings, resignations, and convictions of several abusers. See, for example, Mary Schmich, "2017 Was the Year of the Reckoning," *Chicago Tribune*, 5 December 2017, http://www.chicagotribune.com/news/columnists/schmich/ct-met-word-of-year-mary-schmich-20171205-story.html.

10. For example, after years of public pressure to release its diversity data, Google disclosed in 2014 that in technical roles, women accounted for just 17 percent of the company's employees. Hispanics made up 2 percent and African-Americans 1 percent of the technical workforce. Sheelah Kolhatkar, "The Tech Industry's Gender Discrimination Problem," *New Yorker*, 20 November 2017, https://www.newyorker.com/magazine/2017/11/20/the-tech-industrys-gender-discrimination-problem.

11. "Capture" is a phenomenon in which experts, critics, or government regulators begin to serve the interests of those they should be objectively studying, critiquing, or overseeing. For an overview, see Daniel Carpenter and David A. Moss, eds., *Preventing Regulatory Capture: Special Interest Influence and How to Limit It* (Cambridge: Cambridge University Press, 2013).

12. Bell et al., "Who Becomes an Inventor in America?" 1.

13. Sheila Jasanoff, *The Ethics of Invention: Technology and the Human Future* (New York: W. W. Norton, 2016).

14. David Guston, "Understanding 'Anticipatory Governance,'" *Social Studies of Science* 44, no. 2 (2014): 218–242.