

Stephen Hilgartner, *Reordering Life: Knowledge and Control in the Genomics Revolution* (Cambridge, MA: MIT Press, 2017), 368 pages. ISBN: 9780262035866. Hardcover: \$35.00.

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In *Reordering Life*, Stephen Hilgartner treats us to a fascinating account of the Human Genome Project (HGP) — the 15-year, multibillion-dollar international endeavor that produced the first complete sequence of the three billion DNA base pairs that make up our genome. Hilgartner is professor of science and technology studies at Cornell University. Having conducted some 190 interviews and closely followed the HGP during its lifetime through extensive ethnographic observation in field sites such as labs, sequencing centers, and conferences central to the HGP, Hilgartner offers an insightful analysis of how organizations, technology, and epistemic choices relate to each other in the production of knowledge claims about the human genome.

The HGP raised critical issues for the molecular biology community, issues that often threatened to upend business as usual while at the same time triggering a backlash against the HGP's ambitious objectives. Consider, for example, the proposition of doing biology “big science style,” an entirely novel concept in the mid-1980s. The loose coalition of vanguard scientists driving the idea of an HGP imagined a new era of functional genomics, one in which biologists would study what genes do rather than being bogged down in the technically daunting and time-consuming process of identifying those genes. Quite aside from the question of how to persuade Congress to allocate \$3 billion to do this, how could those scientists convince their fellow biologists that such an initiative would not starve traditional investigator-led research of funding or, worse, that the concentration of mapping and sequencing tasks into a small number of facilities would not do to university laboratories what the opening of a Walmart does to the neighborhood corner shop? Or, at the later point when Craig Venter's Celera Genomics was established with the aim of finishing sequencing the human genome faster and more cheaply than the publicly funded HGP, how to maintain support in the ideological climate of

the mid-1990s, when claims of “business doing it better and cheaper” enjoyed credibility?

These practical questions — of how the HGP was made fundable and ultimately achieved — are in fact only the brackets for Hilgartner's investigation. *Reordering Life* is fundamentally concerned with how the HGP affected and transformed social and epistemic orders of knowledge production. Hilgartner proposes the notion of a knowledge control regime, defined as “a sociotechnical arrangement that *constitutes* categories of agents, spaces, objects, and relationships among them in a manner that allocates entitlement and burdens pertaining to knowledge” (p. 9; emphasis added). According to Hilgartner, operationally, knowledge control regimes structure governing frames; such frames then provide a set of organized schemata for actors to make sense of their situation and inform action. Crucially, scientists work within multiple knowledge control regimes, which intersect and mutually influence each other. While clearly elaborated, this theoretical framework is arguably the most complex part of the book and is worth exploring through an example.

Hilgartner spends some time on the problem of cataloging and making publicly accessible the rapidly growing amounts of sequencing data. Within a time span of two decades, he discerns no fewer than five control regimes of how databases, data producers, data users, funders, and journals interacted. Initially, employees of GenBank — a public repository of annotated gene sequences — would search published journal articles for sequence information and manually enter that data into the database. That strategy became unsustainable amid exploding quantities of data, and as a result, the next regime involved journals mandating that authors of accepted articles submit their data to GenBank.

Fast-forward to the present-day arrangement, and large-scale sequencing centers now release almost real-time data to GenBank, independently of publication. Hilgartner demonstrates that there is a pattern to these successive knowledge control regimes that can be explained by looking at how the jurisdictions of the journal, the laboratory, and the sequence database/data providers relate to each other. As changes pertaining to sequence data production destabilized a prevailing knowledge control regime, the HGP leadership and funders had to find new settlements. These settlements imposed burdens primarily on the large-scale sequencing centers — for example, recasting them as service providers — while dealing most lightly with the laboratories and journals over which the HGP leadership had little control.

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The book discusses several other similarly intricate episodes, including debates about whether to solely sequence protein coding regions of the genome (disregarding “junk” DNA) and the underlying assumptions about sharing and cooperation in designing sequencing strategies. Hilgartner is cautious not to overgeneralize, but he offers three takeaway points. Regime changes are more likely, he argues, first, if they do not usurp existing cultural norms and regimes; second, if they do not make new demands on powerful actors; and third, if measures can be implemented without renegotiating how different regimes relate to each other. He concludes with the observation that “[g]rand visions of technology as a source of utopian social change tend to underappreciate both the resilience and the obduracy of extant orders” (p. 231). In other words, the vanguards of technological and scientific change are ultimately political actors, and observers as well as scholars of science policy need to explicitly recognize them as such.

The book primarily speaks to a postgraduate social science audience familiar with science and technology studies (STS). The writing is clear and to the point, and it is never repetitive. Key genomics concepts are explained with illustrations throughout the empirical chapters, something I found helpful despite familiarity with contemporary human genomics. I would also wholeheartedly recommend the book to political scientists interested in how ideas come to shape policies and material practices, as well as to science policymakers, funders, and scientists implicated in big science initiatives (the human brain project, different initiatives in synthetic and systems biology) who might find its lessons instructive. Lastly, the book might offer a healthy reminder to promoters of precision medicine that more data alone will not suffice in reshaping established practices in our health systems.

Is this a topical book, and what is its contribution? Given the more than 10-year lag between the HGP’s end

and the book’s publication, it clearly needs to offer more than “the HGP story”; it easily surpasses this hurdle, not least because the impressive empirical material and analytical rigor makes it a captivating read. Books with these scholarly (and literary) qualities are few and far between. While the book’s insights into important moments of the HGP alone make it worth reading, it ultimately seeks to make an original contribution to what STS scholars term studies of coproduction of knowledge and social orders. In 1985, Shapin and Schaffer (writing about scientific credibility in early modern science) observed that “the contest among alternative forms of life and their characteristic forms of intellectual product depends upon the political success of the various candidates in insinuating themselves into the activities of other institutions and other interest groups.”¹ Hilgartner’s own insights are remarkably similar, although the two empirical contexts could not be more different in terms of the technologies and epistemic debates at stake. If anything, this makes these insights more robust.

While Hilgartner’s concept of knowledge control regime is original and central to his analysis, Hilgartner could have engaged more with theories of sociological institutionalism, given that they make similar affordances to understanding the constitution of agency and would have introduced fewer new terms because of the longer analytical tradition. To end, with various precision medicine initiatives and human brain projects currently funded around the world, biology as big science clearly has not gone out of favor with funders. This book is a timely contribution to the politics of scientific advancement.

Reference

1. S. Shapin and S. Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985), p. 342.