Agency and Industry

Charles C. Gillispie's "The Natural History of Industry,"
Then and Now

LISSA ROBERTS

Building on Benedetto Croce's famous dictum that "all history is contemporary history," historian David Cannadine published an article in 1984 that canvassed the relationship between how successive generations of economic historians since 1880 analyzed the industrial revolution, on one side, and contemporary economic conditions and concerns on the other.¹ Though his examination ends in 1980, it isn't difficult to recognize which themes are central to more recent economic discussions and histories of industrialization: global exchange and interregional competition on a global scale; the role of (useful) knowledge in economic development; the relationship between human activities and the environment, whether in terms of the availability and use of (scarce) resources or environmental sustainability. Historians of technology are perhaps most familiar with how the contours of these discussions have shaped the debates between such historians as Kenneth Pomeranz, who ascribes the growing gap

Lissa Roberts is a professor of Long-Term Development of Science and Technology in the Department of Science, Technology, and Policy Studies, University of Twente, the Netherlands. She currently directs a research program funded by the Netherlands Organization for Scientific Research (NWO) called "Chemistry in Everyday Life, 1760–1815" and an international research network, "Situating Chemistry, 1760–1840" (www.situatingchemistry.com). Recent publications include *Centres and Cycles of Accumulation in and around the Netherlands* (2011); "The Circulation of Knowledge in Early-Modern Europe" (2012); and "Geographies of Steam: Mapping the Entrepreneurial Activities of Steam Engineers in France during the Second Half of the Eighteenth Century" (2012). This essay began as a Society for the History of Technology (SHOT) presentation in a 2011 session organized by Eric Schatzberg. I thank him for the opportunity and all the Princeton alumni in attendance who gave me the sense that I was on to something interesting. I also thank Suzanne Moon for her support, probing questions, and suggestions, which pushed me to draw much more out of my analysis than I had originally considered.

©2013 by the Society for the History of Technology. All rights reserved
0040-165X/13/5404-0009/922-41

1. Benedetto Croce, *History as the Story of Liberty*, 19; David Cannadine, "The Present and the Past in the English Industrial Revolution," esp. 149–55.

between western Europe and China since the late eighteenth century primarily to the availability of colonial resources and domestically exploitable coal deposits, and those who, like Joel Mokyr, argue instead for the existence of a unique European culture since the eighteenth century that favored the production and diffusion of “useful knowledge” in the context of progressively liberal political institutions.²

Mokyr coined the term “Industrial Enlightenment” to describe what he sees as the phase that spurred an industrial revolution, first in Great Britain and then across various parts of Europe, thereby rooting innovation and economic growth squarely in a causal and geographical context of ideas, attitudes, and institutions. Strikingly, however, this new term actually points to a number of historical claims that were already being asserted, discussed, and debated in the 1950s.³ Thanks to a small but influential number of economists and historians and sociologists of science, the question of the relationship between science and industrialization secured a place on both academic and policy agendas during the height of the cold war. Among those who added their critical voice to the discussion was Princeton historian of science Charles Coulston Gillispie. In twin articles published in 1957, Gillispie offered a unique take on what his contemporaries argued to be the role played by science and scientists in the early phase of modern industrialization.

“The Natural History of Industry” (NHI) and “The Discovery of the Leblanc Process” (DLP) did not create a great stir when they first appeared.⁴ Examining their content and subsequent influence, however, enables an appreciation of what was novel about the articles and yet highly characteristic of the period in which they appeared. And because Gillispie returned to and championed this approach in his most mature works, we can consider what appeared novel and representative in the late 1950s in the context of more recent discussions of the relations between science and industry. Revisiting NHI and DLP thus invites reflection on the historiographical legacy left by Gillispie and his generation and consideration of what we can learn from their work about the history of science and technology as practiced then and now.

Although not developed in this essay, the reader might nonetheless also wish to use this occasion to consider the “methodological geography” implied by Gillispie’s work and responses to it—a geography in which France and French scholarship occupy a prominent position. As we shall see, Gillispie was first drawn to critique the dominant, Anglocentric view of the Industrial Revolution when he (inspired by the historian R. R.

CLASSICS

REVISITED

2. Kenneth Pomeranz, *The Great Divergence*; Joel Mokyr, *The Enlightened Economy* and *The Gifts of Athena*.

3. William J. Ashworth, “The Ghost of Rostow,” esp. 256–60.

4. Charles C. Gillispie, “The Natural History of Industry” and “The Discovery of the Leblanc Process.”

Palmer) began investigating science and technology during the French Revolution.⁵ Ironically, perhaps, this ultimately led him away from the historiographical orientation championed by Alexandre Koyré—an approach that spread from Paris in the 1950s and reified a claimed hierarchical division between the histories of science and technology.⁶ Opting instead for a historical sociology grounded in the study of institutions and social interaction, Gillispie found himself increasingly confronted during the 1980s by analytical approaches seeking to include the nonhuman and material worlds in explanations of historical development—approaches that found particularly fertile soil in the intellectual environment of contemporary Paris, as exemplified especially by the pioneering work of Michel Serres and Bruno Latour.⁷

Genesis and Genealogy: The Early Career of Charles Coulston Gillispie

“Dazzled,” as he put it, “by Hiroshima, the Manhattan Project, sonar, radar, penicillin, and so on,” Gillispie entered graduate school at Harvard following his service in World War II.⁸ With an undergraduate and military background in chemistry, he chose to specialize in the history of science—a field still in the process of forming a stable institutional and intellectual identity in the United States. Electing not to join the circle of George Sarton (also at Harvard), however, Gillispie anchored himself in the history department and began producing a steady stream of work that reflected his twin concerns with historical content and methodology along with his strong sense of community service. Hired by Princeton University in 1947, Gillispie is one of the history of science and technology’s oldest and most respected emeritus professors. His long and productive career can be retrospectively divided into three phases. The first, which culminated with the publication of *The Edge of Objectivity* (1960), was marked by Gillispie’s analytical attention to culture and ideas as the explanatory sources of scientific development.⁹ The second was dominated by his editorship of the *Dictionary of Scientific Biography* (1970–80).¹⁰ The third saw the publication of two volumes that explicitly grounded the revolutionary

5. Charles C. Gillispie, “Apologia pro Vita Sua,” S87.

6. This division comes out most clearly in Alexandre Koyré, “Galileo and Plato,” where he states: “Galileo did not learn his business from people who toiled in the arsenals and shipyards of Venice. Quite the contrary: he taught them theirs” (401).

7. Rather than extensively cite work by Serres and Latour here, I refer the reader to Chandra Mukerji’s discussion of the strengths and weaknesses of their approaches for the history of technology. See Mukerji, *Impossible Engineering*, esp. 203–6, 216–19.

8. Gillispie, “Apologia pro Vita Sua” and “A Professional Life in the History of Science” (quotation from the latter, 15).

9. Charles C. Gillispie, *The Edge of Objectivity*.

10. Charles C. Gillispie, *Dictionary of Scientific Biography*.

relationship between science and polity in France from the end of the Old Regime through the Napoleonic years, in a study of institutions and events rather than ideas.¹¹ Though these volumes appeared in 1980 and 2004, the approach and argument they manifested already informed a pair of articles written in the middle of the first phase of Gillispie's career. Published in *Isis* in 1957, NHI and DLP presented the historical relation between science and industry in a way that fit uneasily between the other publications of this early period, during which Gillispie was especially influenced by historian of science Alexandre Koyré.¹²

Gillispie published two books during the first phase of his career: *Genesis and Geology*, based on his dissertation, and *The Edge of Objectivity*, based on the lectures he gave to Princeton undergraduates during his first years there.¹³ While these books might not seem of direct relevance to the history of technology, examining the approach and historical claims Gillispie developed in each has much to tell us about the dominant methodological visions with which he wrestled during the first phase of his career. Not only does this provide a frame within which to set his composition of NHI and DLP. Both books demonstrate that, from early on, Gillispie wasn't afraid to follow his own instincts, which led to innovative and sometimes controversial results.

Genesis and Geology zooms in on a series of geological debates in Great Britain between 1790 and 1850. While the view that science was historically at war with religion still generally held sway, Gillispie argued that theologically based disputes *within* the scientific community played a role in the debates he examined.¹⁴ Rather than sticking to an internal analysis of scientific knowledge production, as a number of his reviewers preferred, Gillispie went even further by grounding his topic in a rich portrayal of its intellectual life and times.¹⁵ To understand the history of science, he claimed, requires consideration of the cultural, philosophical, social, and political views that color a given scientific community.

It is significant that Gillispie made a point of mentioning his early admiration for both historian of science Alexandre Koyré and sociologist Robert Merton.¹⁶ At first glance, the distance between these two couldn't

11. Charles C. Gillispie, *Science and Polity in France at the End of the Old Regime* and *Science and Polity in France at the End of the Old Regime: The Revolutionary and Napoleonic Years*.

12. Gillispie, "The Natural History of Industry" and "The Discovery of the Leblanc Process"; Pierre Costabel and Charles C. Gillispie, "In Memoriam." I thank Seymour Mauskopf—one of Gillispie's first graduate students—for his recollections of this period.

13. Charles C. Gillispie, *Genesis and Geology* and *The Edge of Objectivity*.

14. J. W. Draper, *History of the Conflict Between Religion and Science*; A. D. White, *A History of the Warfare of Science with Theology in Christendom*.

15. Nicolaas A. Rupke, "C. C. Gillispie's *Genesis and Geology*."

16. Gillispie, "A Professional Life," 16.

OCTOBER

2013

VOL. 54

appear greater; the philosophically trained Koyré sought to reveal the metaphysical underpinnings of science, while the sociologically trained Merton worked to marry what people did with the social and institutional values that contextualized their activities. Gillispie nonetheless incorporated elements of both approaches in *Genesis and Geology*, interpretively framing Merton's eye for empirical evidence and belief that "scientists commonly select for treatment problems which are vitally linked with the dominant values and interests of the day" in conjunction with what he took to be the period's deeper philosophical commitments.¹⁷

One of the things that made this methodological merger possible was the fact that all three believed that modern science generates true knowledge.¹⁸ For Merton, this meant that sociologists could and should leave the analysis of scientific content to scientists.¹⁹ For Gillispie, it not only warranted labeling knowledge claims as true or false. He argued that the history of science has its winners and losers in a sense that goes beyond historical actors' adherence to specific knowledge claims and theories to include the world-views with which they can be associated.²⁰ This tenet guided the thesis of *Genesis and Geology*, but was even more prominent in *The Edge of Objectivity*. Presented as "an essay in the history of scientific ideas," the book offers a judgment-driven overview of scientific development since the seventeenth century, along with the philosophical and methodological commitments that propelled it. Attached to "the edge of objectivity" like a locomotive strapped to a mighty plow, Gillispie declared, science pushed through the obstructive debris of history to propel civilization toward modernity.

As A. Rupert Hall reported in his review of the book, Gillispie had difficulties sustaining his thesis.²¹ What worked in his formulation of the scientific revolution and nineteenth-century physics, both of which he managed to associate with his mathematically oriented definition of objectivity, worked less well for his presentation of the Enlightenment. Focusing on the *philosophes*, Gillispie granted a special character to this era's relation with science. Symbolic of the age for him was Diderot, a *philosophe* who could be labeled neither a "rationalist" nor a "romantic" (that is, neither clearly right nor wrong from Gillispie's perspective). But no matter; while flirting with science and its reactionary twin, according to Gillispie, Diderot bore responsibility for one of the most important publications of the century . . . important because the *Encyclopédie*, in Gillispie's words, offered society a "natural history of industry."²² To understand what he

17. Robert K. Merton, *Science, Technology, and Society in Seventeenth-Century England*; Koyré, "Galileo and Plato."

18. Alexandre Koyré, *Metaphysics and Measurement*, esp. 3.

19. Steven Shapin, "Understanding the Merton Thesis," esp. 595.

20. Rupke, "C. C. Gillispie's *Genesis and Geology*," 264.

21. A. Rupert Hall, "Review of Charles C. Gillispie, *The Edge of Objectivity*."

22. *Ibid.*, 180, 174.

meant by this phrase, we need to examine his 1957 article of the same name.

The Natural History of Industry

Gillispie spent the academic year 1954–55 doing research in Paris. Although it was during this year that he became friends with Koyré, it was also at this time that he embarked on a project that would take his work in a very different direction, leading ultimately to the publication of *Science and Polity in France at the End of the Old Regime* (1980) and *Science and Polity in France: The Revolutionary and Napoleonic Years* (2004). The first fruits of his research appeared in 1957 as two articles that examined “what sort of influence science exerted on industrialization in the eighteenth century.”²³ The first, “The Discovery of the Leblanc Process” (DLP), reconstructs the history behind Nicolas Leblanc’s efforts to convert salt into soda at the turn of the nineteenth century. The other, “The Natural History of Industry” (NHI), offers more general remarks about the historical relationship between science and industrialization. Together, they propose a historiographical alternative to the approach of both *Genesis and Geology* and *The Edge of Objectivity*, foreshadowing the perspective that informed Gillispie’s mature work. As he would later explain, the choice was between integrating science with history in terms of “configurations of ideas or culture” or through the examination of “events and institutions.”²⁴

Although subsequent historians have questioned Gillispie’s identification of what he saw as Leblanc’s “eureka moment,” his broader narrative of the origins and early years of the Leblanc process still provides a fairly standard introduction to the topic.²⁵ As he told it, soda ash and potash were crucial for the manufacture of a wide range of products during the eighteenth century, including glass, textiles, gunpowder, soap, and paper. Deforestation in both England and France (the geographical centers of Gillispie’s study) meant that much potash (wood ash) had to be imported—largely from North America, Scandinavia, and Russia. Soda ash, on the other hand, relied upon the availability of coastal plants with a high saline content, the best of which came from Spain and the Canary Islands. Following the disruptions of the Seven Years’ War and its aftermath, as well as supply problems emanating from Spain, it made good mercantile sense to find a domestic substitute, and a number of people—ranging from entrepreneurial artisans and factory directors to a Benedictine abbot named Malherbe, the industrial chemist Jean-Antoine Chaptal, and the

CLASSICS
REVISITED

23. Gillispie, “The Discovery of the Leblanc Process,” 152.

24. Gillispie, *Science and Polity in France at the End of the Old Regime*, 549.

25. Frederick Lawrence Holmes, *Eighteenth-Century Chemistry as an Investigative Enterprise*, 98–101; John Graham Smith, *The Origins and Early Development of the Heavy Chemical Industry in France*, 209–15.

OCTOBER
2013
VOL. 54

lawyer turned chemical amateur Louis-Bernard Guyton de Morveau—set about doing so. The search for a substitute took place in an equally wide range of locations, including private laboratories patronized or used directly by nobles seeking new sources of income, as well as in the contexts of glass manufacture and the bleaching industry.

The continued vulnerability caused by French dependence on foreign resources led to official encouragement of domestic innovation. Especially with gunpowder production (managed by the royal government's Régie des Poudres) sucking up increasing supplies of potash, the Parisian Académie des Sciences offered a monetary award in 1783 for the best new method of producing alkali from sea salt. Among those who responded was Nicolas Leblanc, then employed as surgeon to the duc d'Orléans. Leblanc had been exploring the nature of salts and the problem of alkali production for some time. In need of financial backing to pursue his work, he turned to the duke with the claim that he had isolated a successful method of producing alkali. In order to verify Leblanc's claim, the duke had him replicate his work in the chemistry laboratory at the Collège de France. Together with Michel Dizé, assistant to the college's professor of chemistry, Jean Darcet (who also served as director of the royal porcelain works at Sèvres), Leblanc refined the process for which he received an award from the academy in 1789. He then went on to apply for one of the first patents offered by revolutionary France's new patent regime. By 1791, with the duke's financial backing and watchful eye, he and Dizé set up a production plant.

Briefly stated, the process involved three stages: 1) bring sea salt and sulfuric acid into reaction; 2) fuse the resulting sodium sulfate with charcoal and limestone by heating them in a reverberatory furnace; and 3) refine the resulting raw soda to concentrate the alkali content. Leblanc's decision to use limestone was the original and key element of the process's success in chemical terms. It would be quite some time, however, before the process was a practical success, thanks to a number of factors including capitalization; availability of materials; realization of the process on an industrial scale; government support in the form of helpful economic, industrial, and taxation policies; and competition from other manufacturers using different processes. It was far from obvious at the time, in other words, that the Leblanc process was the "best" option available. It initially appeared neither as the most efficient nor the most cost-effective process, points that were underscored by Leblanc's own inability to develop a successful plant before his death by suicide in 1806.

Gillispie drew three primary lessons from his evidence. First, as stated, was his conclusion that the success of the Leblanc process was neither obvious nor immediate. By the time Leblanc and his industrial partners went to work in 1791, a dozen other processes were known, and artificial soda was being manufactured in at least five separate establishments. And

while none of these endeavors led to soda being produced as the principal object of manufacture, neither was Leblanc able to dislodge dependence on Spanish ingredients. Achieving industrial independence in this case would, in fact, take more than twenty years. Gillispie reckoned that Leblanc and his partners probably produced no more than 30,000 pounds of soda by the time they were forced to shut down in 1793 because of the inability to procure necessary substances, which were also needed for munitions production. By the time the government decided to publicize Leblanc's process in 1794, as part of an emergency program to expand production of needed wartime supplies, Leblanc was busy in his new post at the national Agence des Poudres.

Second, although Gillispie didn't draw much explicit attention to this point, his presentation certainly raises the question of what it means to speak of the "Leblanc process" as Leblanc's own discovery. Leblanc seems to be the first to have turned experimentally to limestone in this context, a key ingredient in the process. But he was unable to uncover all the steps actually needed to produce artificial soda, especially on a scale required for industrial production. What subsequently came to be called the Leblanc process was itself the product of collaboration, particularly with Dizé, who had developed the hybrid knowledge and ability needed to bring laboratory experimentation and industrial practices together. This fits well with recent developments in our understanding of eighteenth-century chemistry. Even the most iconic figure of the chemical revolution, Lavoisier, has been shown to have been a hybrid actor, simultaneously engaged in material and knowledge production at sites such as the royal government's Régie des Poudres.²⁶ We also know that countless apothecaries who busied themselves on a daily basis with the challenges of commerce and product innovation became members of scientific societies and found time to contribute to their journals, often with knowledge derived from their work-related investigations. And by tracing the careers of numerous academic chemists, historians have shown that many were not at all averse to engaging in chemical manufacture, mining, and the like.²⁷ As hard as one might try, finding the *practical* boundary between science and industry—between material and knowledge production, to put it more generally—has been shown to be a highly difficult, if not impossible task. Yet, despite the historical evidence that Gillispie's research provided for this position, he built on his investigation's third lesson to distinguish between science and industry and explain their relationship.

Gillispie presented the context in which he chose to discuss the relationship between science and industry as more than just an artifact of his research. He offered his "natural history of French industry" as a counter-

26. Bernadette Vincent-Bensaude, *Lavoisier, mémoires d'une révolution*.

27. Ursula Klein, ed., "Artisanal-Scientific Experts in Eighteenth-Century France and Germany."

point to the dominant narrative of his day, which anchored the origins of modern industrialization in Great Britain.²⁸ “Neither science nor industrialization,” he wrote, “has ever been national in scope, and to consider a question related to the industrial revolution in a framework other than British may have the merit of modifying the tendency to see this great event in the exclusive perspective of the Midlands of England and the Lowlands of Scotland.”²⁹ Gillispie prepared the ground for his analysis by portraying eighteenth-century France as fundamentally different from Britain, posing a familiar opposition between the cultures born of French centralization and individual, private initiative across the channel.³⁰ In answer to Robert Schofield’s contemporary study of Birmingham’s Lunar Society—founded by and for the likes of Boulton, Watt, and Wedgwood—Gillispie offered the Parisian Académie des Sciences:³¹

[T]echnical activity is one thing, but power of abstract thought is another; and it may well be wondered whether a certain vulgarity in this British utilitarianism—thoroughly evident, for example, in Bacon—was not responsible for the relative poverty of British achievement over the centuries in the abstract reaches of scientific thought; and further whether the French instinct to separate thought and practise [*sic*], while giving each its due, was not by the same token responsible for the formal elegance and intellectual eminence of French scientific leadership in its great days.³²

Mentioning Bacon in this context was not without consequence. If Bacon was often presented as the patron saint of the British industrial revolution, Gillispie proffered the Enlightenment philosopher Condillac as an important source of inspiration in France.³³ Condillac’s sensationalism equated knowledge acquisition with the mundane task of attending to and ordering sense-based experience. By tying the production of knowledge to the way in which humans physically engage with the world, he also provided a productively pregnant scheme for scientific and industrial development.³⁴ The organizing power of scientific taxonomies and nomencla-

28. David Cannadine, “The Present and the Past in the English Industrial Revolution, 1880–1980,” esp. 154.

29. Gillispie, “The Natural History of Industry,” 398.

30. For a critique of this characterization of eighteenth-century British society and economy, see John Brewer, *The Sinews of Power*.

31. Robert E. Schofield, “The Industrial Orientation of Science in the Lunar Society of Birmingham.” For a more recent study, see Jenny Uglow, *The Lunar Men*.

32. Gillispie, “The Natural History of Industry,” 403.

33. See, for example, Benjamin Farrington, *Francis Bacon*.

34. Etienne Bonnot de Condillac, *Traité des sensations*. The classic study remains William Randall Albury, *The Logic of Condillac and the Structure of French Chemical and Biological Theory*. For a more critical view, see Lissa Roberts, “Condillac, Lavoisier and the Instrumentalization of Science.”

tures—evident in contemporary botany, chemistry, and Enlightenment encyclopedias—fed the fires of French industry by fixing the natural world in an order that could be apprehended as both an internal process of understanding and an outwardly directed process of organized productivity. It was especially thanks to the proliferation and circulation of encyclopedic projects and publications, according to Gillispie, that Leblanc and others were led to explore nature in an orderly way, to search for and recognize analogies between the known and the unknown.

CLASSICS
REVISITED

On one side, this accounts for how Enlightenment science—which through its analytical ordering offered a natural history of industry—fed Leblanc’s inventive program of discovery and application. On the other side, it clarifies Gillispie’s defining identification of “Enlightenment scientists.” Attached to academic institutions (both institutions of learning and scientific academies and societies) and government organizations, Enlightenment scientists doubled as managers and educators. In the first of these roles, they constrained development by managing the system of rewards and privileges within which French industry was pursued; members of the Académie des Sciences were charged with evaluating inventions for which aspirants sought official approbation.³⁵ In the second role, they stimulated innovation by expanding, organizing, and circulating the supply of knowledge and by encouraging analytical and analogical thinking, such as that which led Leblanc to experiment with using limestone to produce artificial soda. It was with this in mind that Gillispie enunciated his core thesis: “The eighteenth-century application of science to industry, then, was little more and nothing less than the attempt to develop a natural history of industry” (405).

Quotations rarely speak for themselves, however, and we must still interpret what he meant here. One could turn to the profuse evidence Gillispie unearthed of the hybrid character of French industrialization, composed of mutually reinforcing material and knowledge production. But more telling was his final judgment that, at least in France, “science governed the arts”—a view that leaves little room either for the hybrid historical relation between material and knowledge production or for the decentralized character of countless initiatives that fed productive innovation.³⁶ Echoing Lavoisier’s twilight defense of the Académie des Sciences as necessary for the advance of science, Gillispie dehistoricized his distinction between those who pursue industrial progress for the sake of economic advance and scientists, who are motivated by a different temperament or instinct. “The scientist works for love of science and to increase his own reputation,” Gillispie wrote. “Society benefits both from the disinterested investigation of the *savant* and the interested speculation of the artisan.

35. The classic study of the Académie des Sciences remains Roger Hahn, *The Anatomy of a Scientific Institution*; see also Liliane Hilaire-Pérez, “Invention and the State in Eighteenth-Century France.”

36. Gillispie, “The Natural History of Industry,” 401.

Confound the two, however, and both will lose the spirit distinctive to them."³⁷

It was Robert Merton, of course, who most famously declared disinterestedness a fundamental scientific value.³⁸ Also in a sociological vein, Gillispie situated science and scientists in the explanatory context of an institutionally grounded historical sociology of enablements and constraints. Bracketed between his reference to "the French instinct to separate thought and practice" and to Jacobin rule as a historical aberration during which time France's free scientific spirit was held captive by a romantic dictatorship of utility, Gillispie identified the scientists in his story. Scientists, on one hand, held the social rank of *savant*—generally through academy membership or patronage—and, on the other hand, held governmental or advisory positions through which they could assert watchful management over the hybrid field of material and knowledge production.³⁹ The implication is that good science and top-rate scientists need freedom and encouragement both to thrive and to guide others; governmental coercion, whether gentle or Jacobin, can only have a retarding influence. This is an ideologically laden message to be sure, which seems to fit comfortably in the cold war mode of rhetoric about scientific progress popular during the 1950s when Gillispie wrote NHI and DLP.

But if Gillispie appears to have fit neatly within what has been called "the old big picture" that projected a narrative celebration of the ideals of progress and objectivity, Gillispie intended NHI as a critique of two of the central tenets of this "big picture" narrative.⁴⁰ As enunciated most explicitly by economist W. W. Rostow, the rise of modern science was presented not only as heralding progress and objectivity in the production of knowledge, it was presented as forming a package deal with the march of liberty and industrially driven economic growth. More specifically, in *The Stages of Economic Growth: A Non-Communist Manifesto*, Rostow situated the roots of "take-off" (his term for modern economic growth) in Great Britain, where "the spirit of science and productive gadgeteering" took hold of the population.⁴¹ Gillispie wrote NHI to challenge the historical adequacy of both the so-called linear model, according to which scientific theories historically informed industrial application and thereby powered material and socioeconomic progress, and the Anglocentric view that the industrial revolution—the linear model's poster child—was first and foremost a

37. Ibid., 402–3.

38. On Mertonian norms, see Robert K. Merton, "Science and Technology in a Democratic Order."

39. Quotation from Gillispie, "The Natural History of Industry," 403. On the "romantic moralism" of Jacobin science and its opposition to modern science's "edge of objectivity," see Charles C. Gillispie, "The *Encyclopédie* and the Jacobin Philosophy of Science."

40. Andrew Cunningham and Perry Williams, "De-centring the 'Big Picture.'"

41. W. W. Rostow, *The Stages of Economic Growth*, 32.

British phenomenon.⁴² While still granting science priority over the arts and industry during the historical phase denominated by Rostow and others as leading to “take-off,” Gillispie argued for a recognition of historical and cultural variation both in the pursuit of science and, consequently, its precise relation with the (commercial) world of material productivity.

Science, Technology, and Polity in a Material World

CLASSICS

REVISED

Among Gillispie’s many critical readers was Gillispie himself. When he published the results of more than two decades of further research on the role of science in late ancien régime France in 1980, he included a telling comment. Researching and writing his book, he averred, “has increasingly led me to think that the integration of science into history is to be attempted with better prospects through the medium of events and institutions than through configurations of ideas or culture.”⁴³ This is a major departure from the tribute his first two books paid to Koyré, and a vindication of the approach embodied in DLP and NHI. As we have seen, however, focusing on events and institutions did not keep Gillispie from interpreting history according to his own deeply held ideas about the nature of science and the character of those who populated and interacted with its institutions. This concluding section examines the legacy of his approach. It begins with a few words about Gillispie’s two-volume study of science and polity in late ancien régime, revolutionary, and Napoleonic France and then examines the implications of his exchange with fellow historian Ken Alder, prompted by his review of Alder’s rather different interpretation of the same topic.⁴⁴ At stake, as we shall see, is whether the history of science, technology, and the world they have inhabited and helped to transform is best understood by keeping the social world analytically distinct from the material world and granting agency only to humans.

Gillispie concluded his first volume with a modification of the thesis that he originally proposed in NHI. After years of research and reflection, he decided that it was “too categorical to say that the development of theory had nothing to do with the increasing sophistication of the chemistry of dyes.”⁴⁵ Although now making room in his explanation of the relationship between Enlightenment science and industry to include theory devel-

42. On the “linear model,” see Benoît Godin, “The Linear Model of Innovation”; Lissa Roberts, “The Circulation of Knowledge in Early Modern Europe,” esp. 50–51. For a critique of Rostow’s vision of scientific, industrial, and economic progress and its recent resurgence, see Ashworth, “The Ghost of Rostow.”

43. Gillispie, *Science and Polity in France at the End of the Old Regime*, 549.

44. Ibid.; Gillispie, *Science and Polity in France at the End of the Old Regime: The Revolutionary and Napoleonic Years*; C. C. Gillispie and Ken Alder, “Exchange: Engineering the Revolution.”

45. Gillispie, *Science and Polity in France at the End of the Old Regime*, 551.

OCTOBER

2013

VOL. 54

opment and application, none of what he wrote negated his primary characterization of French scientists at this time as managers and educators. By also calling attention to scientists as theoretical knowledge producers, rather, Gillispie underscored his continued allegiance to the Mertonian belief that scientists were/are motivated by a desire for autonomy and professional status:

As for scientists, what have they wanted of governments? They expressly have not wished to be politicized. They have wanted support, in the obvious form of funds, but also in the shape of institutionalization and in the provision of authority for the legitimation of their community in its existence and in its activities, or in other words for its professional status.⁴⁶

An immediate implication of this understanding of science, Gillispie explained, was that its relationship with the state was that of a limited partnership. While politics and political power were bound to be partisan, science and its practitioners remained true to their professional mission “to provide the monarchy with the services and knowledge of experts and in return to draw advantages from the state for the furthering of science.”⁴⁷ What scientists contributed and managed was productive power, which was in and of itself politically neutral. This would remain true throughout France’s revolutionary years, Gillispie averred, and the age of modernity they ushered in.

With this as his summation of the historical relationship between science and the state, it is not surprising that Gillispie was critical of claims that the productive power scientists designed and managed was, in fact, essentially political. *Technology and Culture* gave him a platform to elaborate on this in 1998, when it published his review of Alder’s *Engineering the Revolution*.⁴⁸ For Gillispie, the categorical distinctions embodied in political and scientific institutions were not simply justified by some practical principle of administrative efficiency, but more fundamentally by what he took to be the definitional essence of politics and science. Politicians, as stated, wield partisan power over people. Scientists design productive power in a professionally disinterested way, lending their knowledgeable expertise to the state and society through education and the management of productivity. Alder’s book, which analyzes how a group of artillery engineers sought to reform the design, production, and use of guns during France’s late Enlightenment and revolutionary years, might be seen as a case study of the relationship between these two powers. But by arguing that guns embodied politics, Alder based his argument on what Gillispie considered a fundamental categorical mistake.

46. *Ibid.*, 549.

47. *Ibid.*, 550.

48. Ken Alder, *Engineering the Revolution*.

A bit of clarification is in order here. Gillispie was concerned foremost with the history of science, while Alder presented his history of gun design and production as concerned with technology and technological artifacts. One might object that comparing Gillispie to Alder is thus not actually pertinent. It was Gillispie, however, who initiated this dialogue by reviewing Alder's book. Second, despite his own thesis, Gillispie offered convincing historical evidence against the existence of a clear and stable practical boundary between *science* and *technology* in both DLP and NHI. Further, the content of Gillispie's and Alder's positions justifies the comparison in two ways. First, we recall that the purpose of NHI was to address the relationship between science and industry during the late French Enlightenment and Revolution. By describing scientists as institutionally embedded managers and educators of material productivity, Gillispie helped pave the way for Alder's analysis of the French artillery engineers who transformed gun design and production during this period. And by insisting on the existence of a culture of professional expertise, whereby politically neutral scientists were driven by the twin motives of disinterested knowledge production and reputation, he begged the question of whether the production, education, and management of productive power (the three tasks he assigned to scientists) can indeed be seen as politically neutral. From here, it is a small step to asking whether the material results of such activities can be regarded as politically neutral as well.

Returning to their published exchange, Alder offered this gloss on Gillispie's perspective:

Gillispie's implicit argument here is that artifacts are created by engineers (or artisans or inventors) whose personal politics, sources of funding, and forms of social organization do not help, hinder, or even unduly influence their efforts to transform the brute stuff of matter into effective technologies. Applied to modern technology, this argument often reduces to the fallacy of "applied science" and technological determinism. But in any case it is wed to a narrow, functionalist view of technology.

This interpretation is not without its problems. First, Gillispie's taxonomy placed scientifically trained and professionally institutionalized engineers in a different category than artisans and inventors, whom he saw as motivated by profit. It was thus his adherence to the ideal of neutral scientific professionalism, combined with his confinement of politics to the realm of human interaction, that stood in the way of accepting Alder's argument. Second is Alder's concern with the link between Gillispie's position and the specters of applied science and technological determinism. We recall that one of the primary themes of NHI was to argue against the applicability of the linear model, which so easily distinguishes between "pure" and "applied" science, to the period he studied. Ironically, by aligning his analysis

OCTOBER
2013
VOL. 54

of the “technological life” of engineers who managed “large systems of workers, soldiers, and weapons” with the perspective of Langdon Winner, it was Alder who could be seen as treading the slippery slope of technological determinism.⁴⁹ Nonetheless, Alder was right on the money to see Gillispie’s approach as “wed to a narrow, functionalist view of technology.”

The key term here is *functionalist*, which brings us back to the sociological underpinnings of Gillispie’s history. Functionalism was the dominant mode of American sociological analysis in the 1950s, characterized by Daniel Bell as marking “the end of ideology,” but clearly reflecting the ideology of cold war liberalism. Agency in this context is understood as a social phenomenon; that is, judgmentally shaped on one hand by norms, institutions, and (according to Merton) functionalism’s mirror-image twin, dysfunction, and denied to nonhumans on the other. Key to functionalism’s view is its faith in both the natural and social sciences, whose professional practitioners can be counted on to advise the state in technocratic fashion regarding how to manage nature and society for the benefit of the greater good.⁵⁰ Alder gestured toward a world organized by other interpretive principles, one in which faith in the technocratic neutrality of scientific expertise is misplaced, in which politics is not limited to governments wielding coercive power over people, and in which humans share agency with nonhumans. Consciously inhabiting this world entails leaving behind the oppositional categories of the *social* and *material* whereby analyses of change can be charted on a continuum ranging between social construction and technological determinism, with faith in disinterested science and objective nature situated somewhere in the middle. In the words of sociologist Andrew Pickering, it requires living “in the thick of things”—that is, “in the intersection between the human and the non-human” where intertwined ontologies of becoming replace the interaction between distinct and predefined categories of being.⁵¹ Not only does this perspective allow for technological artifacts to have politics, it questions the very categorical distinction projected to guard the boundary between the material and social realms. As such, it offers a very different way to analyze the past, think about the present, and engineer the future.

Mukerji recently employed this perspective in her account of the Canal du Midi.⁵² By including government ministers, entrepreneurs, engineers, peasants, maps, tools, rocks, wind, and water as actors in her story, Mukerji

49. Ibid., xii; Gillispie and Alder, “Exchange,” 742; Langdon Winner, “Do Artifacts Have Politics?” See especially Winner’s discussion of nuclear power plants.

50. Daniel Bell, *The End of Ideology*; Jon Wiener, “Bringing Nazi Sympathizers to the US.” For a historical overview of functionalism’s development, see John Holmwood, “Functionalism and Its Critics.” For the link between functionalism and technocracy, see Anthony Welch, “Technocracy, Uncertainty and Ethics,” esp. 24–30.

51. Andrew Pickering, “New Ontologies.”

52. Mukerji, *Impossible Engineering*.

convincingly demonstrated that seventeenth-century France was governed by the intertwining of two sorts of political power: the coercive domination of strategic power—what Gillispie recognized as partisan politics—and the impersonal, productive power of logistics, which organized the material world in ways that affected the social order. Enrolling elements of nature to build infrastructure, such as the Canal du Midi, was, by this count, a political act involving the exertion of power as it aimed to increase it. Importantly, success depended not only on the humanly engineered construction of infrastructure, but also on the ongoing cooperation of those natural elements that its construction entailed, changed as their own force was by its presence. The integrity of sea walls and locks, which were held together by the combined genius of stone, water pressure, and human engineering, depended on the dynamic stability of their union; one gusty storm or surge of water could destroy years of planning and collaborative work.⁵³

Pickering offered a similar lesson in his portrayal of the history of the Mississippi River.⁵⁴ With the growth of towns and cities along its banks, levees were constructed to safeguard urban settlements and transportation routes. These engineering efforts, however, never succeeded in taming the river. Rather, the work of engineers and the river's evolution formed a hybrid dance in which elements of nature and materialized engineering moved over time toward the Gulf of Mexico—sometimes flowing elegantly, other times destructively escaping its banks. Significantly, the U.S. Army Corps of Engineers generally viewed their relationship with the river, not as a “dance of agency,” but as a battle to control nature. If water showed an inclination to leave the Mississippi for one of its tributaries, this would have to be stopped in order to sustain trade and transportation routes that fortified the socioeconomic position of New Orleans. Never able to gain the upper hand, however, adversarial engineering finally gave way to the danse macabre let loose by Hurricane Katrina.

Would history have turned out differently along the Mississippi and Gulf Coast had the modern lens of expert control not been the filter through which policymakers considered society and nature to relate? Commentators posed just this question in the wake of Katrina, idealizing the Dutch integrated approach to water management as both example of an alternative past and blueprint for a sustainable future.⁵⁵ As historians, we can take away two complementary lessons from this. First, however we choose to analyze the past, the object of our study is, in fact, a complexly hybrid weave of material and social interaction that gives the lie to those who seek to shut

53. Lissa Roberts, “A Very Human Tale.”

54. Andrew Pickering, “New Ontologies,” esp. 4–6; John McPhee, *The Control of Nature*; Craig Colten, *An Unnatural Metropolis*.

55. Suzanne Goldenberg, “US Urged to Abandon Ageing Flood Defences in Favour of Dutch System”; Cornelis Disco, “Delta Blues.”

OCTOBER

2013

VOL. 54

out either element of historical evolution. Second, the interpretative choices we make nonetheless matter because they warrant particular visions of the past, as they justify or critique power relations of the present and provide roadmaps for the future. Gillispie's perspective reflected the age of growth and promised prosperity in which his own career took off—an age in which science and technology were celebrated for their contribution to a world of material comfort and social liberty.⁵⁶ Can we afford to accept it today?

Bibliography

Published Sources

- Albury, William Randall. "The Logic of Condillac and the Structure of French Chemical and Biological Theory, 1780–1801" (Ph.D. diss., Johns Hopkins University, 1972).
- Alder, Ken. *Engineering the Revolution: Arms and Enlightenment in France, 1763–1815*. Princeton, NJ: Princeton University Press, 1997.
- Ashworth, William J. "The Ghost of Rostow: Science, Culture and the British Industrial Revolution." *History of Science* 46, no. 3 (2008): 249–74.
- Bell, Daniel. *The End of Ideology: On the Exhaustion of Political Ideas in the Fifties*. New York: Free Press, 1960.
- Brewer, John. *The Sinews of Power: War, Money and the English State, 1688–1783*. London: Routledge, 1989.
- Cannadine, David. "The Present and the Past in the English Industrial Revolution, 1880–1980." *Past and Present* 103 (1984): 131–72.
- Colten, Craig. *An Unnatural Metropolis: Wrestling New Orleans from Nature*. Baton Rouge: Louisiana State University Press, 2005.
- Condillac, Etienne Bonnot de. *Traité des sensations*. Paris, 1754.
- Costabel, Pierre, and Charles C. Gillispie, "In Memoriam: Alexandre Koyré." *Archives Internationales d'Histoire des Sciences* 17 (1964): 150–56.
- Croce, Benedetto. *History as the Story of Liberty*. London: Allen & Unwin, 1941.
- Cunningham, Andrew, and Perry Williams. "De-centring the 'Big Picture': The Origins of Modern Science and the Modern Origins of Science." *British Journal of the History of Science* 26, no. 4 (1993): 407–32.
- Disco, Cornelis. "Delta Blues." *Technology and Culture* 47, no. 7 (2006): 341–48.
- Draper, J. W. *History of the Conflict Between Religion and Science*. New York: Appleton, 1874.
- Farrington, Benjamin. *Francis Bacon: Philosopher of Industrial Science*. New York: Henry Schuman, 1949.
- Gillispie, Charles C. *Genesis and Geology: A Study in the Relations of Sci-*

56. Cannadine, "The Present and the Past in the English Industrial Revolution," esp. 149–55.

- entific Thought, Natural Theology, and Social Opinion in Great Britain, 1790–1850*. Cambridge, MA: Harvard University Press, 1951.
- _____. “The Discovery of the Leblanc Process.” *Isis* 48, no. 2 (1957): 152–70.
- _____. “The Natural History of Industry.” *Isis* 48, no. 4 (1957): 398–407.
- _____. *The Edge of Objectivity: An Essay in the History of Scientific Ideas*. Princeton, NJ: Princeton University Press, 1960.
- _____. “The *Encyclopédie* and the Jacobin Philosophy of Science: A Study in Ideas and Consequences.” In *Critical Problems in the History of Science*, edited by Marshall Clagett, 255–89. Madison: University of Wisconsin Press, 1962.
- _____. *Science and Polity in France at the End of the Old Regime*. Princeton, NJ: Princeton University Press, 1980.
- _____. “Apologia pro Vita Sua.” *Isis* 90, supplement (1999): S84–S94.
- _____. “A Professional Life in the History of Science.” *Historically Speaking: The Bulletin of the Historical Society* 3, no. 3 (2004): 2–6. (Reprinted in *A Master of Science History: Essays in Honor of Charles Coulston Gillispie*, edited by Jed Z. Buchwald, 15–24. Dordrecht: Springer, 2012.)
- _____. *Science and Polity in France at the End of the Old Regime: The Revolutionary and Napoleonic Years*. Princeton, NJ: Princeton University Press, 2004.
- _____, ed. *Dictionary of Scientific Biography*, 16 vols. New York: Charles Scribner’s Sons, 1970–80.
- _____, and Ken Alder, “Exchange: *Engineering the Revolution*.” *Technology and Culture* 39, no. 4 (1998): 733–54.
- Godin, Benoît. “The Linear Model of Innovation: The Historical Construction of an Analytical Framework.” *Science, Technology & Human Values* 31, no. 6 (2006): 639–67.
- Goldenberg, Suzanne. “US Urged to Abandon Ageing Flood Defences in Favour of Dutch System.” *Guardian* (London), 5 June 2009, available at <http://www.theguardian.com/environment/2009/jun/05/flooding-us-defence> (accessed 24 September 2013).
- Hahn, Roger. *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803*. Berkeley: University of California Press, 1971.
- Hall, A. Rupert. “Review of *The Edge of Objectivity: An Essay in the History of Scientific Ideas*, by Charles C. Gillispie.” *Isis* 51, no. 3 (1960): 344–47.
- Hilaire-Pérez, Liliane. “Invention and the State in Eighteenth-Century France.” *Technology and Culture* 32, no. 4 (1991): 911–31.
- Holmes, Frederick Lawrence. *Eighteenth-Century Chemistry as an Investigative Enterprise*. Berkeley: Office for the History of Science and Technology, 1989, 98–101.
- Holmwood, John. “Functionalism and Its Critics.” In *Modern Social Theory: An Introduction*, edited by Austin Harrington, 87–110. Oxford: Oxford University Press, 2005.

CLASSICS
REVISITED

- Klein, Ursula, ed. "Artisanal-Scientific Experts in Eighteenth-Century France and Germany." Special issue of *Annals of Science* 69, no. 3 (2012).
- Koyré, Alexandre. "Galileo and Plato." *Journal in the History of Ideas* 4, no. 4 (1943): 400–428.
- _____. *Metaphysics and Measurement*. London: Chapman & Hall, 1968.
- McPhee, John. *The Control of Nature*. New York: Farrar, Straus and Giroux, 1989.
- Merton, Robert K. *Science, Technology, and Society in Seventeenth-Century England. Osiris: Studies on the History and Philosophy of Science and on the History of Learning and Culture* (1938), 360–632.
- _____. "Science and Technology in a Democratic Order." *Journal of Legal and Political Sociology* 1 (1942): 115–26. (Reprinted as "The Normative Structure of Science," in Merton, *The Sociology of Science: Theoretical and Empirical Investigations* [Chicago: University of Chicago Press, 1973], 267–78.)
- Mokyr, Joel. *The Gifts of Athena: Historical Origins of the Knowledge Economy*. Princeton, NJ: Princeton University Press, 2003.
- _____. *The Enlightened Economy: An Economic History of Britain, 1700–1850*. New Haven, CT: Yale University Press, 2009.
- Mukerji, Chandra. *Impossible Engineering: Technology and Territoriality on the Canal du Midi*. Princeton, NJ: Princeton University Press, 2009.
- Pickering, Andrew. "New Ontologies." In *The Mangle in Practice: Science, Society and Becoming*, edited by Andrew Pickering and Keith Guzik, 1–14. Durham, NC: Duke University Press, 2008.
- Pomeranz, Kenneth. *The Great Divergence: China, Europe, and the Making of the Modern World Economy*. Princeton, NJ: Princeton University Press, 2000.
- Roberts, Lissa. "Condillac, Lavoisier and the Instrumentalization of Science." *The Eighteenth Century* 33, no. 3 (1992): 252–71.
- _____. "A Very Human Tale." *History and Technology* 27, no. 2 (2011): 187–95.
- _____. "The Circulation of Knowledge in Early Modern Europe: Embodiment, Mobility, Learning and Knowing." In *History of Technology*, vol. 31, edited by Ian Inkster, 47–68. London: Bloomsbury, 2012.
- Rostow, W. W. *The Stages of Economic Growth: A Non-Communist Manifesto*. Cambridge: Cambridge University Press, 1960.
- Rupke, Nicolaas A. "C. C. Gillispie's *Genesis and Geology*." *Isis* 85, no. 2 (1994): 261–70.
- Schofield, Robert E. "The Industrial Orientation of Science in the Lunar Society of Birmingham." *Isis* 48, no. 4 (1957): 408–15.
- Shapin, Steven. "Understanding the Merton Thesis." *Isis* 79, no. 4 (1988): 594–605.
- Smith, John Graham. *The Origins and Early Development of the Heavy Chemical Industry in France*. Oxford: Oxford University Press, 1979.

- Uglow, Jenny. *The Lunar Men: The Friends Who Made the Future, 1730–1810*. London: Faber and Faber, 2002.
- Vincent-Bensaude, Bernadette. *Lavoisier, mémoires d'une révolution*. Paris: Flammarion, 1993.
- Welch, Anthony. "Technocracy, Uncertainty and Ethics: Comparative Education in an Era of Postmodernity and Globalization." In *Comparative Education: The Dialectic of the Global and the Local*, 2nd ed., edited by Robert F. Arnove and Carlos Alberto Torres, 24–51. Lanham, MD: Rowman & Littlefield, 2003.
- White, A. D. *A History of the Warfare of Science with Theology in Christendom*. New York: Appleton, 1896.
- Wiener, Jon. "Bringing Nazi Sympathizers to the US: Talcott Parson's Role." In *Professors, Politics, and Pop*, 79–86. New York: Verso Press, 1991.
- Winner, Langdon. "Do Artifacts Have Politics?" In *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, 19–39. Chicago: University of Chicago Press, 1986.

CLASSICS
REVISITED