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Modern Intellectual History / Volume 7 / Issue 03 / November 2010, pp 629 - 642
DOI: 10.1017/S1479244310000260, Published online: 30 September 2010

Modern Intellectual History, 7, 3 (2010), pp. 629–642
doi:10.1017/S1479244310000260

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Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven: Yale University Press, 2007)

At the end of *Matters of Exchange*, Harold Cook's major revisionist account of the early modern scientific revolution, he locates the political and economic writings of Bernard Mandeville within the practices and values of contemporaneous Dutch observational medicine. Like Mandeville, Cook describes the potency of early modern capitalism and its attendant value system in generating industry and knowledge; like Mandeville, Cook finds coercive systems of moral regulation to be mistaken in their estimation of human capacities; and like Mandeville, Cook does not shy away from the violence that often made the worldwide commerce in matters of fact possible. "Every Part was full of Vice," famously rhymed Mandeville, "Yet the whole Mass a Paradise."[1] The practices and values of science, this book suggests, stemmed from the vices of the merchant and the consumer, not the *sprezzatura* of the baroque courtier, the asceticism of the Christian gentleman, the speculation of the university philosopher, or the dour appraisal of the theologian. Interest, not claims to disinterest, made modern science and its attendant values possible. Scrupulous attention to goods from around the world and right at home created the conditions for natural knowledge.

Matters of Exchange sets out to account for nothing less than the heart of modern science, which Cook takes to be the accumulation, study, verification, and exchange of matters of fact (414–15). Comprising a series of richly contextualized case studies, the book is resplendent in detailed examples, which evoke the merchants, schools and gardens of Leiden and Amsterdam; which grimly detail the murderous underpinnings of the spice trade in Southeast Asia; and which capture the remarkable two-way exchange of medical information between the Dutch and the Japanese. Cook integrates the scholarly literature on

[1] B. Mandeville, *The Fable of the Bees, or, Private Vices, Publick Benefits*, ed. F. B. Kaye, vol. 1 (Oxford, 1957), p. 24.

consumerism and taste with that of "matters of fact" to set forth an engaging portrait of the supply and demand supporting the new empirical sciences. He locates the creation of matters of fact in the interaction of people across social groups and in varied spaces, in the Netherlands and beyond. Cook introduces us to a rich array of Dutch physicians, botanists, and explorers; details the networks that made their achievements possible; and demonstrates their scientific contributions while simultaneously dispersing the agency allowing those contributions. The book offers innovative accounts of famous figures such as Clusius, Descartes, Boerhaave, and Mandeville, all the while introducing readers to a range of Dutch figures that should be far better known to non-Dutch readers. No analytical review can do justice to the range of materials Cook presents.

Matters of Exchange provides an unapologetically grand narrative of an early modern scientific revolution, cast in a series of dichotomies: the speculative versus the empirical, general principles versus particulars, grand systems versus acute material observations, "right reason" versus "natural reason," abstract reasoning versus conscientious and humble investigation of material things, religious dogma versus freethinking liberty, theoretical incommensurability versus global material exchange. In each case, Cook largely scorns the former and valorizes the latter. My primary criticisms of the book focus on the perils of drawing these dichotomies too sharply. While providing the richest survey of early modern fact production to date, Cook's account often downplays the artifactual nature of fact production and threatens to homogenize the tensions, disagreements, and varying theoretical commitments of different sorts of empirical practitioner. The book explores too little how the proliferation of fact spurred the creation of innovative means of theorizing, generalizing, and classifying. Cook treats scientific and ethical materialism as nonspeculative inferences from attention to matters of fact; such materialisms are better understood as hypotheses, powerful but nevertheless underdetermined by matters of fact. None of these complaints negates the profound shift Cook's account effects in our understanding of the people and places of fact production in early modernity.

COMMERCIAL AND SCIENTIFIC VALUES

For Cook, the decisive practice necessary for modern science is descriptive naturalism, by which he means something like the pursuit of the detailed description of material qualities of objects alongside a commitment to a purely naturalistic (or materialist) understanding of the world. Cook is not concerned with the traditional, theoretically oriented scientific revolution from Copernicus to Newton. He argues instead that a more significant contemporaneous transformation in natural knowledge based on descriptive naturalism must be

understood as the source of the central evidential practices and values of science. *Matters of Exchange* offers a maximalist "matter-of-fact" approach to a scientific revolution of the seventeenth century.

In Cook's account, the study of matters of fact, including the practices and set of values central to that study, emerged in and was spurred by the capitalist economy, its values, and its practices within the relative freedom of inquiry of the Dutch republic in its Golden Age. "The new philosophy," he writes in the conclusion, "arose . . . from the objective values inculcated by commerce" (415). Often the language and evidence are more correlative than causative:

> In short, then, a number of values were shared by both merchants and those we would now call scientists . . . Exchange values, openly based on both passion and calculation, placed certain forms of knowing about objects, even living objects, front and center. When such values began to reorient natural philosophy, something recognizably like modern science emerged. (57; cf. 81)

Far from hindering science or perverting its internally produced goals, norms, and values, the global capitalism of the Dutch shared, if it did not actually provide, the rich set of values essential to scientific practice.

Cook asks what motivated this shift in values, such that "investigating empirical details" seemed "satisfying." His answer is not one of a narrow intellectual history:

> The explanation lies not in better concepts but in shifting priorities. As commercial cities and the financial capital they produced became ever more important for the larger political systems of which they were a part, the values of the urban merchants, including their intellectual values, were increasingly dominant throughout society. (411)

A culture dedicated to observing, documenting, and trading facts sprang from the practices, values, and interests of commercial people in a relatively liberal polity. The drive for material gain, once freed from the dogmatic veils of external morality and philosophy, led, furthermore, to an empirically valid understanding of human beings as passionate, self-interested creatures. Commerce led to the abandonment of particular philosophical doctrines and—far more devastating—undermined the entire place of theology and metaphysics for dictating the best course of life. Commercial goods overtook the Good as object of inquiry and as primary motivation for action.

OBSTACLES AND TECHNIQUES OF EXPERIENCE

Jakob Burckhardt famously set forth the concrete political and religious situation in a factional Italy as the condition of possibility for and then causal explanation of the emergence of the modern subject of knowledge during the

Renaissance. The people produced under these conditions lost, in a turn of phrase that still riles medievalists, the dogmatic "veils" obscuring reality itself. In much older history of science, the emergence of new ways of experiencing the world independent of philosophical or theological veils came rather in the seventeenth century with figures such as Robert Boyle and Blaise Pascal and their innovative experimental practices, all perhaps guided by the tutelary spirit of Francis Bacon. In their crucial reworking of the story of Boyle and the Royal Society, *Leviathan and the Air-Pump*, Steven Shapin and Simon Schaffer took the canonical figure of Boyle as the initiator of the modern "experimental life" as something to be largely accepted, but also to be explained. Shapin and Schaffer used Thomas Hobbes as a foil to Boyle, to bring out the artifactual nature of the experimental life and the strangeness of fact-making as a solution to the problem of knowledge production. They described the "technologies" necessary to make the "experimental life" first possible, then nearly irresistible, and ultimately self-evident.[2] In Shapin and Schaffer's account, making facts was hard and nonobvious; so was making up people and social forms dedicated to producing facts and creating a modest natural philosophy from them. Instead of seeing theoretical or dogmatic blinders needing to be eliminated in order finally to observe nature in itself, Shapin and Schaffer discussed the cognitive and social technologies that made certain kinds of empirical experience, its documentation, and its dissemination possible. Whatever the empirical and theoretical problems of their classic study, it offered a powerful alternative to naive positivism focused exclusively on observation and to an idealist postpositivism focused only on theories or on the cognitive preconditions to all experience.[3]

In his recent *The Science of Describing*, Brian Ogilvie presents a genealogy of the artifices constitutive of the exact description of natural history. He argues that by "the end of the sixteenth century, naturalists had developed a sophisticated technology of observation and description, a technology that allowed them to transmit local knowledge through precise description and communication." Naturalists of this period

> continued to observe particulars carefully, to pay attention to the surface characteristics of *naturalia*, and to delight in the variety of nature. But their experiences were shaped by assumptions about what they would see and habits for observing it. There is no such thing as "pure experience" of nature

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2 S. Shapin and S. Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (Princeton, 1985).

3 For these two approaches and attempts to overcome the opposition between them see, among the vast literature, P. Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago, 1997), 781–803.

independent of their techniques, training, and concepts.[4] Ogilvie offers a post-Kuhnian account of botanical observation that neither privileges theory absolutely nor allows for direct accounting of things seen absent some bad cognitive commitments and dogmatic beliefs.

Rather than focusing upon the strangeness and artifice of observational technique, Cook emphasizes the ubiquity of empirical interest and observational competence in the commercial world of the Netherlands, with its focus on goods and on the development of taste. To describe this competence Cook defines "objectivity" in a novel way, as "a knowledge appertaining to a detailed acquaintance with objects" (17). The knowledge in question in this "objectivity" is more akin to connoisseurship than to theoretical natural knowledge. "Objectivity" refers "to matters that pertain to the knowledge of objects without reference to intuition or innate knowledge, the corporeal knowledge of things that can be experienced by the bodily senses, information from which can be exchanged" (*sic*, 19). The knowledge of this "objectivity" encompasses the observable properties of particular things and ways of using, transforming, and preserving them. In Cook's telling, objectivity in everyday commerce in, and evaluation of, objects allows for the development of objectivity understood as a nontheoretical, empirically derived, and confirmable description of an object. The wide distribution of this objectivity in the Netherlands provided the conditions necessary for the sustained expansion of the interest in, and support for, empirical inquiry.

The interests of the commercial actors of the Netherlands demanded they see things as they really are; they could not afford to have dogmatic veils obscuring the view of reality. In contrast to approaches stressing the impossibility of "pure experience" of nature, Cook's *Matters of Exchange* returns in many ways to a model of obstacles removed to permit such unimpeded experience. "The development of natural knowledge in the Dutch Republic, then, depended not only on the new values of commerce but on the ability of those pursuing the facts to escape the domination of rational dogmas of many kinds" (84). Readers of *Matters of Exchange* may feel caught between two strands within the history and philosophy of science. On the one hand, the book offers a form of cultural, constructivist post-Kuhnianism that investigates the values and "moral economies" making different forms of observation possible; such an approach details the structures that produced practitioners able to observe with particular priorities, techniques, and competencies. On the other hand, the book often seems committed to an older style of positivism that prioritizes the observation, accumulation, and

4 B. W. Ogilvie, *Science of Describing: Natural History in Renaissance Europe* (Chicago, 2006), 209, 140.

verification of facts, a pursuit made possible once the veils of dogmatism had been torn away.

Matters of Exchange powerfully groups together many examples of modest empirical inquiry as part of a more general push for "objectivity." Experience and matters of fact are capacious categories in Cook's account: they include invasive experimentalism and microscopic inquiry, detailed botanical description and long-term Hippocratic medical observation, the discernment of a goldsmith and the therapeutic wisdom of a local herbal expert.[5] While demonstrating the practice of many naturalists of drawing upon a wide range of empirical sources, Cook does not, however, provide an analytical taxonomy of the variety of empirical work he describes or a map of the tensions among different sorts of empirical practitioners.

Practitioners committed to matters of fact disagreed vociferously about the correct form of empirical inquiry. Mandeville paused, in the middle of a diatribe against the use of mathematics in practical medicine, to condemn certain botanical authors for their "curious Exactness in the Description" of plants, "as to Shape and Colour, the Time a Plant blows at, what Number of Leaves the Flower is compos'd of, what it bears, and which Class it is to be rank'd in; *and not a Syllable of what it is good for.*"[6] Exact description had become an end in itself. Following the "empirical" physician Thomas Sydenham, Mandeville valorized prolonged experience of the patient, not detailed anatomies, microscopic observation, or iatrochemical explanations. Too exact description of the sort practiced by skilled naturalists was a preening, deceptive waste—not unlike theory production.

Cook's account is not entirely clear on how fine-grained an explanation of technical practices the values of Dutch commercial life provide or what relationship "objectivity" had to the detailed practices of different sorts of empirical practitioners. Is this objectivity a necessary, but insufficient, condition for the emergence of a widespread commitment to empirical inquiry? According to Cook, the culture of matters of fact resulted from values shared by commerce and science: "travel, seeing things afresh, exchange, commensurability, credibility, the hope of a better material future through worldly activity, and a preference for plain and precise language" (57). However essential to scientific practice these values were, they do not appear sufficient to produce precise practices and technologies of description, or to ensure consensus about what is observed, or even what ought to be observed.

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5 For the variety of forms of experience see P. Dear, "The Meanings of Experience," in K. Park and L. Daston, eds., *Cambridge History of Science: Early Modern Science* (Cambridge, 2006), 106–31.

6 B. Mandeville, *A Treatise of the Hypochondriack and Hysterick Diseases In Three Dialogues*, 3rd edn (London, 1730), 197, my italics.

INDUSTRY AND ANALYSIS

Accompanying Cook's claims about the values of commerce in general are illuminating examples of concrete investigative procedures adapted from the world of trade. The great microscopic discoveries of the late seventeenth century rested as much on innovative techniques of preparation and preservation as on improvements in optics. The microscopist Jan Swammerdam used oil of turpentine to preserve bodily tissues and organs, before injecting their vessels with air, wax and other substances; these artificial techniques revealed microstructures of the body previously only hypothesized about. Cook characteristically begins his account of the development of these preservation techniques not with the canonical figure Swammerdam but with a mania for mumia in mid-century. After long experimentation, the Flemish nobleman Lodewijk De Bils had developed an extraordinarily efficacious embalming practice that allowed for preservation of bodies without removal of viscera and without the desiccation necessary in other methods. No university professor, De Bils was out to make a guilder in a market fascinated by the prospect of preservation. Numerous sovereign powers sought to acquire the technique. De Bils at one point promised to reveal the secret for 120,000 guilders. His technique involved a long series of operations involving an indistinct mixture of chemicals, spices and balms, including oil of turpentine, our Chian turpentine (279).

Likely drawing upon De Bils's techniques, Swammerdam and his colleagues isolated oil of turpentine as the essential chemical in the process and perfected the technique necessary for their anatomical discoveries: "What had begun as an attempt to preserve bodies from the process of decay had developed into a range of experimental techniques crucial to gaining anatomical knowledge" (281). To demand documentary proof of this transmission in detail would be to demand a form of proof that would systematically exclude nonelite historical actors. In a well-known endnote to *The Cheese and the Worms*, Carlo Ginzburg rails against overly stringent standards of proof that lead always to "'demonstrating' that ideas by definition originate *always and only* in educated circles . . . in the heads of monks and university professors, certainly not of millers or of peasants."[7] To open historical practice to the contrary demands a reworking of canons of demonstration alongside a willingness to see different actors as sources of innovation and information—a willingness put to impressive use throughout *Matters of Exchange*. Here, more than in any other study, Cook provides a survey of the diverse producers of such knowledge that will serve as a foundation for

7 C. Ginzburg, *The Cheese and the Worms: The Cosmos of a Sixteenth-Century Miller*, trans. J. Tedeschi and A. Tedeschi (Baltimore, 1980), 155, italics in original.

future work in categorizing these producers and in appreciating their distinct but complimentary contributions to natural knowledge.

What accounted, then, for Swammerdam's success in isolating the essential ingredients from De Bils's concoction?[8] De Bils and Swammerdam both knew how to do something—but the nature of their understanding of that process appears to be of a radically different order, however much both fit within Cook's culture of matters of fact. How should we distinguish the knowledge of technique of De Bils from that of Swammerdam—and what differences in that sort of knowledge matter? Despite all the convincing work on craft and tacit knowledge in the history of science and in studies of indigenous knowledge, we lack a sufficiently nuanced taxonomy of and vocabulary for discussing different categories of craft knowledges, which include propositional knowledge, discernment in judgment, skilled manual dexterity, and so forth—including Cook's "objectivity."[9]

DISPERSED AUTHORSHIP

In 2005 the publication of an English translation of a major work of early modern medicinal botany, Hendrik van Reede's twelve-volume *Hortus Malabaricus* (1678–1703), was a cause for celebration and consternation in India, and not just out of antiquarian interest. The translator and his team, one important Indian commentator noted, have "contributed significantly towards the safeguarding of our [sc. India's] natural plant wealth and indigenous knowledge from being exploited by foreign commercial interests."[10] Some indigenous-rights groups worried, with some reason, that the translation would simply aid foreign bioprospecting. As Cook discusses, the matters of fact in *Hortus* came largely from a variety of indigenous practitioners, especially non-Brahmin healers of the Ezhava. The *Hortus* provides the best record of the indigenous medical knowledge of the early modern peoples of Malabar—hence its political importance to India as "prior art" in the current climate of rapacious bioprospecting.

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8 Compare D. Margocsy, "Advertising Cadavers in the Republic of Letters: Anatomical Publications in the Early Modern Netherlands," *British Journal for the History of Science* 42 (2009), 187–210, esp. 187–90.

9 For recent studies of artisanal knowledge see P. H. Smith, "Science on the Move: Recent Trends in the History of Early Modern Science," *Renaissance Quarterly* n62 (2009), 345–75, esp. 361–4.

10 H. Y. Mohan Ram, "On the English Edition of *Hortus Malabaricus* by K. S. Manilal (2005)," *Current Science* 89 (2005), 1672–80, esp. 1675; see also S. Reddy, "Making Heritage Legible: Who Owns Traditional Medical Knowledge?", *International Journal of Cultural Property* 13 (2006), 161–88, esp. 168–73.

A major upshot of *Matters of Exchange* is that the published scientific works of early modern Europe should be seen as reifications of dense networks of exchange and skill, of the knowledge and—importantly—of the judgment of peoples across the globe:

> The publication of books on the medicine and natural history of East Asia was the outcome of countless human relationships . . . It involved famous and anonymous people . . . Similar networks were also deeply involved in interpreting the results of these apparent matters of fact and deciding on how much they could be trusted and used. Human agency was at work on the part of all of the participants, not just the European intellectuals. The issue of the "authorship" of many early modern books, and certainly of the development of new medical practices, is therefore very much open to interpretation. (376)

If many historians of science would now readily accept some version of this argument, none has demonstrated it with such global scope and diversity of example as has Cook.[11]

In a peculiar polemical moment midway through the book, Cook criticizes Richard Grove, whose pioneering work on the dependence of European natural history on non-European sources one might expect Cook to embrace. According to Cook, Grove has "asserted rather than demonstrated" that the classificatory systems and theoretical precepts of South Asian ethnobotany were essential to Van Reede's *Hortus Malabaricus* (313).[12] While Cook leaves the resolution of this question open for further empirical investigation, he largely rejects the transfer of theoretical, systematic, or generalized knowledge across cultures as central to the exchanges of the period. Such transfers violate his general account of the nature of global exchange of things and knowledge about things. No matter how incommensurable theory and "culture" are, Cook maintains, matters of fact about the observable properties and uses of things are commensurable:

> Many things crossed from one language to another, but they tended to be those of the world of objectivity: of plain nouns, adjectives, and verbs that refer to what the senses tell us. Abstract concepts crossed much less readily, and then only in a confused manner . . . Culture certainly made translating the whys and wherefores as understood by

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[11] For indigenous knowledge and early modern sciences see, e.g., L. L. Schiebinger and C. Swan, eds., *Colonial Botany: Science, Commerce, and Politics in the Early Modern World* (Philadelphia, 2005); J. Delbourgo and N. Dew, eds., *Science and Empire in the Atlantic World* (New York, 2008); K. Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (Basingstoke, 2007). For "authorship" in science studies, see M. Biagioli and P. L. Galison, eds., *Scientific Authorship: Credit and Intellectual Property in Science* (New York, 2003).

[12] See R. Grove, "Indigenous Knowledge and the Significance of South-West India for Portuguese and Dutch Constructions of Tropical Nature," *Modern Asian Studies* 30 (1996), 121–43, esp. 136–40.

one group extraordinarily difficult. But it was no barrier to useful goods or the business of how to do something. Global trade encouraged materialistic exchanges. (377)

Non-Europeans had plenty of theoretical and classificatory systems; according to Cook those systems were stripped out in the process of intellectual and commercial exchange. Europeans and those with whom they exchanged all primarily sought matters of fact. Japanese physicians turned, for example, "to the Dutch on [the island of] Deshima, continuing to admire their descriptive accuracy and ingenuity without appreciating their philosophical principles" (346). Much like (backward) Europeans mired in religion and philosophical doctrine, the Japanese struggled under "classical Chinese concepts, which often held up the unification of moral, natural, and medical cosmologies as the ideal" (345). Matters of fact, in Cook's telling, offered an escape from such confining systems—if only, as in the Netherlands, institutional arrangements would permit that escape into objectivity.

Cook's salutary dispersal of authorship leads to the question of what, if anything, was superior about expert Europeans and specifically the Dutch empiricists? Clearly it was no innate superiority, nor even a philosophically driven superiority. A late chapter on medicine provides the best evidence for Cook's account of their limited epistemic superiority:

The new and experimental physician was not superior to the empiric because he used reason and the empiric did not but because of the superior experience he had gathered from any and all sources. And he was superior to the dogmatist because he refused to speculate beyond the observable. In both instances, what drove him to be better than the others was his pride in his ability to get things right even when it upset the preachers of virtue. (409)

Pride—not disinterest or asceticism or philosophical rigor—produced and regulated the epistemic virtues characteristic of the best of Dutch practitioners: skill in collecting from as many sources as possible, a refusal to go beyond the observed facts, and an unwillingness to be constrained by philosophical or religious dogma.

NOT JUST THE FACTS

Late in the third edition of *Experimental Principles of Mathematical Philosophy*, Isaac Newton collected a variety of data concerning the "weights of bodies in different regions of the earth" in order to demonstrate the flattening of the Earth at the poles. Newton's data came from astronomers sent "to distant regions"—the islands of Cayenne, of St Helena, of Gorée, of Guadeloupe, of

Martinique, of Grenada, and so forth.[13] In spite of its geographic reach, Newton's argument remained unconvincing to Continental philosophers. In the 1730s, the Paris Académie des sciences sent a pair of expositions to Peru and to Lapland to perform more careful empirical observations.[14] Proving—or disproving—Newton's theory demanded the increased creation and circulation of matters of fact.[15] Producing assent to the foremost theoretical achievement of the traditional scientific revolution rested precisely on the expansion and deepening of the sorts of global networks of production and exchange of fact Cook so well depicts.

A major refrain in *Matters of Exchange* is the Dutch refusal to speculate. Cook argues that "the values shared by science and commerce" went beyond fact collection to include "an attentive appreciation for collective generalizations based on exacting information about the objects" in question (57). Absent from *Matters of Exchange* is a systematic discussion of the forms of collective generalization; that is, a discussion of the varieties of classification, generalization, and theorization from matters of fact so characteristic of the age. The beginning of the seventh chapter suggests Cook's general stance: "However much speculation and theory excited argument, the development of knowledge in medicine and natural history depended on accurate description" (267). For Cook, the category of "refusing to speculate" includes all approaches to knowledge that did not start from theological or metaphysical first principles in order to make claims about the ultimate constituents of nature. It thus encompasses numerous different empirically oriented methods that refused to speculate in this way.

Who more famously refused to speculate than Newton? Newton's experimental principles of natural philosophy offered an empirically grounded riposte to Descartes's principles of philosophy and similar philosophical systems. He refused to confine his work to the cataloging of matters of fact. This refusal to speculate (in a bad way) was connected to the insistence on reasoning *from* particulars, on generalizing in an appropriate way, to produce empirically verified but still mathematical principles for reasoning, to produce theories with claims to be depictions of the actual constitution of the world, if not its final causes or ultimate metaphysical principles. Newton's was but the most famous attempt to create new forms of generalization and theoretical reasoning that avoided the dogmatic ways of old. By not focusing on generalization and theory creation, Cook can superbly detail a wider array of producers of facts and stress the integrity of collecting

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13 I. Newton, *The* Principia*: Mathematical Principles of Natural Philosophy*, trans. I. B. Cohen and A. M. Whitman (Berkeley, 1999), Book III, prop. 20, problem 4, 826, 829–30.

14 See M. Terrall, *The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment* (Chicago, 2002).

15 See now S. Schaffer, "Newton on the Beach: The Information Order of *Principia Mathematica*," *History of Science* 47 (2009), pp. 243–76.

facts as a practice. His almost exclusive focus on fact production and exchange, however, cannot do justice to the dynamic production of new ways of reasoning from matters of fact—an efflorescence integrally connected to the proliferation of fact.

"REFUSAL TO SPECULATE" AND THE TWO DOGMAS OF MATERIALISM

One of the peculiarities of *Matters of Exchange* is its portrayal of materialism as somehow non-theoretical, as less speculative than other philosophical systems—a portrayal Cook shares with other major recent revisionist accounts of Enlightenment thought. Newton refused to speculate publicly about possible mechanical explanations for gravity: to offer such speculative explanations would be to proffer the hypotheses he had banished. The epistemic modesty of most of the writers in *Matters of Exchange* meant that they did not make claims about the ultimate constituents of matter; many doubted that such knowledge could ever be attained. Throughout the text, Cook glosses their views as "materialist," at times meaning a concern with those things that can be observed in the world around us, at other times meaning something like a limitation of the ultimate constituents of the world to matter in motion. Often Cook seems to suggest that an exclusive attention to observation of materials around us would necessarily lead to a conviction that the world is but matter in motion, including the passionate, self-interested human beings in it. In Cook's explanatory framework, a hedonist materialism underlay the knowledge production that yielded a (nonspeculative) natural philosophical materialism. Natural philosophical materialism in turn helped promote and justify new naturalistic defenses of ethical materialism, above all in Mandeville.

Maximizing long-term self-interest was one important early modern answer to the proper use of reason given the new empirical understanding of human nature, but it was far from the only one. An empirical approach to human nature and a revalorization of some passions and interests did not exclude other ways of regulating and organizing one's life using reason along with the passions. Not all doctrines calling upon purely rational principles need to be understood as quasi-theological dogmas or metaphysical shadowboxing. Much as Cook's account does not discuss the dynamic production of theories and forms of generalization building from empirical experience, his account underplays the production of innovative normative accounts of the proper connection between reason and the passions in the ethical life.

In his *Enquiry Concerning the Principles of Morals*, David Hume complained that establishing the "selfish hypothesis" requires "the highest stretch of philosophy." The "obvious appearance of things" includes "such dispositions

as benevolence and generosity; such affections as love, friendship, compassion, gratitude." Recondite philosophy, "by penetrating deeper into human nature, may prove" these "to be nothing but modifications of" the selfish passions. Such efforts were precisely the sort of system-building scorned by Enlightenment thinkers—and Cook himself. "All attempts of this kind," Hume argued, "have hitherto proved fruitless, and seem to have proceeded entirely, from that love of *simplicity*, which has been the source of much false reasoning in philosophy."[16] Reducing human motivations to self-interest was just as metaphysical and speculative as reducing the entire universe to matter in motion, however theoretically parsimonious such reductions may be. Neither reduction belongs in a properly empirical science. When Hume sought to produce an experimental study of human nature, in which he denied the sufficiency of self-interest in explaining human action, he modeled it, rhetorically at least, on Newton's attempt to bridge theory and practice in an appropriately modest way.

To believe in such a self-interested actor was to speculate; to believe in a materialist world, likewise, was to speculate. Early modern philosophers, of course, often collapsed empiricism and materialism into one another. In his profoundly influential *Institutes*, Boerhaave argued, "we should fix on some principles whose certainty and effects are *demonstrable* to our senses, which may serve to explain the *phaenomena* of natural bodies . . . ; such only are those which are purely material in the human Body, with *mechanical* and physical experiments."[17] Boerhaave undertook to provide mechanical explanations, which were in principle grounded in a materialist physics. Cook explains Boerhaave's strategy: "The physician should therefore confine himself to materialistic explanations only, based as they were on demonstrations of anatomy, chemistry, and mechanics via the natural and experimental philosophy" (393). Boerhaave, however, soon became skeptical of such materialist reductions and abandoned his lingering dogmatic Cartesian materialism: his refusal to speculate deepened, and he cast aspersions on central materialist dogmas taken as first principles. He did so through a greater understanding of the Newtonian critique of mechanistic explanation as well as through a deepening appreciation of the microscopic matters of fact of Swammerdam, Leeuwenhoek, and others.[18]

Boerhaave's move toward a deeper epistemic modesty under the impress of a culture of fact shows the power of Cook's general account. The details of

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16 D. Hume, *An Enquiry Concerning the Principles of Morals*, ed. T. Beauchamp (Oxford, 1998), appendix 2, paragraph 2.

17 H. Boerhaave, *Dr. Boerhaave's Academical Lectures on the Theory of Physic*, 2nd edn, vol. 1 (London, 1751), 63 (orthography modernized).

18 See R. Knoeff, *Herman Boerhaave (1668–1738): Calvinist Chemist and Physician* (Amsterdam, 2002), 175–82.

Boerhaave's heightened concerns about the dangers of materialist speculation illustrate the need for a more nuanced account of different forms of "materialism" and "materialist" explanation within that culture of matters of fact. Far from leading inexorably to a materialist ontology, the collection of matters of fact led in the eighteenth century to a sophisticated skeptical stance toward materialistic reduction in natural philosophy and ethics alike.[19]

HOW THE DUTCH THINK, IN COOK, FOR EXAMPLE

In his conclusion, Cook argues,

> To the eyes of the twentieth and twenty-first centuries . . . the notion that science begins with material facts instead of theories sometimes seems simple-minded. But placing a high value on getting the facts right before generalizing about their meaning remains necessary for judging worldly events quickly and accurately and is the foundation on which the modern information economy still rests. (414–15)

However necessary attention to facts is in a modern information economy and its technological antecedents, their sufficiency absent generalizing, theorizing, and categorizing is far from obvious.[20] Rectifying the deplorable excess of attention to theory in too much historiography is no reason to deny its long-term importance. To insist too strongly on a binary of fact versus speculation underestimates a crucial dimension of the new scientific practices of the early modern period: the plethora of innovative ways precisely of connecting new fact and theory, empirical particulars and generalization, individuals and systems of classification.

Mandeville shared with Cook the view that theory change does not capture well progress in natural knowledge. "The real Knowledge we have of Nature beyond the Ancients," Mandeville argued, would not "amount to much," except for that knowledge "indebted for to Observation." The "explication of her Operations" changes with times: "you may all along observe a fashion in Philosophizing as much as in wearing of clothes."[21] Even as he mocked their proliferation, Mandeville was a master producer of innovative hypotheses based on detailed observation. A remarkable empirical investigation of early modern fact coupled to a bold hypothesis about its commercial origin, *Matters of Exchange* demonstrates again the power of hypothesis when linked to careful detailed inquiry.

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19 For nonmetaphysical materialism see the nuanced assessment in C. T. Wolfe and M. Terada, "The Animal Economy as Object and Program in Montpellier Vitalism," *Science in Context* 21 (2008), 537–79.

20 For an incisive discussion showing how the success of Wikipedia challenges the view that the modern information economy rests upon getting the facts right see D. Runciman, "Like Boiling a Frog," *London Review of Books* 31 (2009), pp. 14–16.

21 Mandeville, *A Treatise*, 124.