

much as in transformations in their manufacture. The point deserves to be stressed explicitly. I do not question that print enabled the stabilization of texts, to some extent; although fixity was far rarer and harder to discern in early modern Europe than most modern historians assume. I do, however, question the character of the link between the two. Printed texts were not intrinsically trustworthy. When they were in fact trusted, it was only as a result of hard work. Fixity was in the eye of the beholder, and its recognition could not be maintained without continuing effort. At no point could it be counted on to reside irremissibly in the object itself, and it was always liable to contradiction. Those faced with using the press to create and sustain knowledge thus found themselves confronting a culture characterized by nothing so much as indeterminacy. If printing held no necessary bond to truth, neither did it show a necessary bond to falsity or corruption. Each link remained vulnerable to dispute. It is this epistemic indeterminacy that lends the history of the book its powerful impact on cultural history. Understanding how it could be overcome to make knowledge and hence cultural change is what the history of the book is for.

There did exist strategies that could be adopted in order to secure as much credibility for printed objects as readers needed. Chapters 6 and 7 describe such strategies, as pursued by gentlemen and philosophers in a number of different settings. They argue that their pursuit was vital for the establishment of both new philosophies of nature and new practices of knowledge-making. A central tactic in most cases was that of attributing trust to a book on the basis of an evaluation of a person. Look closely at attributions of credit to printed materials, and, as already noted, there will generally be an attribution of credit to an individual involved. "It must be only by the Marks and Properties of an *Imposture*, that we can know an *Imposture* from that which is a real Truth, when attested unto us," counseled Humphrey Prideaux in a much-read analysis of the credibility of alleged scriptural writings. But in identifying such "marks" of imposture, attention should center on consideration of its maker and his conduct. If the producer seemed a wicked man, using "craft" and "fraud" to propagate a claim for his own interest, then that claim could justifiably be accounted a falsehood.⁵⁷ Prideaux's recommendation was conventional enough. Similar exhortations appeared in many works of his era. In action, these skills were therefore intriguingly recursive. Readers assigned credit to printed materials

57. Prideaux, *True Nature of Imposture*, "A Discourse for the Vindicating of Christianity from the Charge of Imposture," 6–8. For a fascinating and extremely suggestive treatment of early strategies of credit adopted in an effort to circumvent piracy, see Newman, "Word Made Print." For bible printing and reading see also Cole, "Dynamics of Printing," and Tribble, *Margins and Marginality*, 11–56.

on the grounds of knowledge about their makers, which was in turn assessed partly in terms of printed sources already accredited. In such ways might knowledge become more secure.

But this was only one of many possible strategies. From the printing house and bookshop, through the craft center of Stationers' Hall, to the learned sites of the Royal Society of London and the Royal Observatory at Greenwich, *The Nature of the Book* identifies the techniques developed in each location by which books could be appraised and accredited. The use of print for making knowledge depended on these local practices of printing, exchange, and reading. The bookshop and printing house were regularly identified as places of promise and achievement. But they were also centers of conflict, plotting, and betrayal, where the proprietor could exhibit a notable fluidity of social identity. In anachronistic terms, he or she—the book trades were remarkable for the participation of both men and women—merged the roles of socialite, friend, ally, entrepreneur, and even spy. His or her responsibility for the contents of a book seemed almost infinitely negotiable: however tactically unwise, outbursts such as those by Grassi and Scheiner against the bookseller were not intrinsically unreasonable. Hence the merging of trust in people with trust in things. Concerns over the effect of printing were readily expressed in terms of such practitioners. Bookshops represented points of attraction for potential Brunos and Patrizis, it was said, in part because those who ran them were so inclined. They were also frighteningly good at their work. To flirt with anachronism once more, besides being manufacturers of credit, seventeenth-century booksellers were the best sociologists of literature of their day.

The autonomy and creativity of Continental scholar-printers in these respects are well known. Eisenstein conjured an image of what she called "print-shops" as "'polyglot' households"—nodal points for the transfer of people, writings, and knowledge. The European "print-shop," she suggested, was where the "scholar" and the "craftsman" really met.⁵⁸ In some respects, and under certain circumstances, the smaller printing house or bookshop of London, Paris, or Rome could become a similar social site. Indeed, the household unit typically found here was perhaps rather more appropriate for such sociability than the relatively large operation of an Elzevir or a Plantin. But it also had to operate under more evident regulatory constraints. Eisenstein's view was that printers and booksellers were "natural" enemies to outside regulation of any kind. In fact, this was far from the case. In cities like London and Paris, the vast majority supported licensing

58. Eisenstein, *Printing Press*, 139, 399–400, 443–7, 520–2, 581–603, 653–4. Compare Zilsel, "Genesis of the Concept of Scientific Progress."

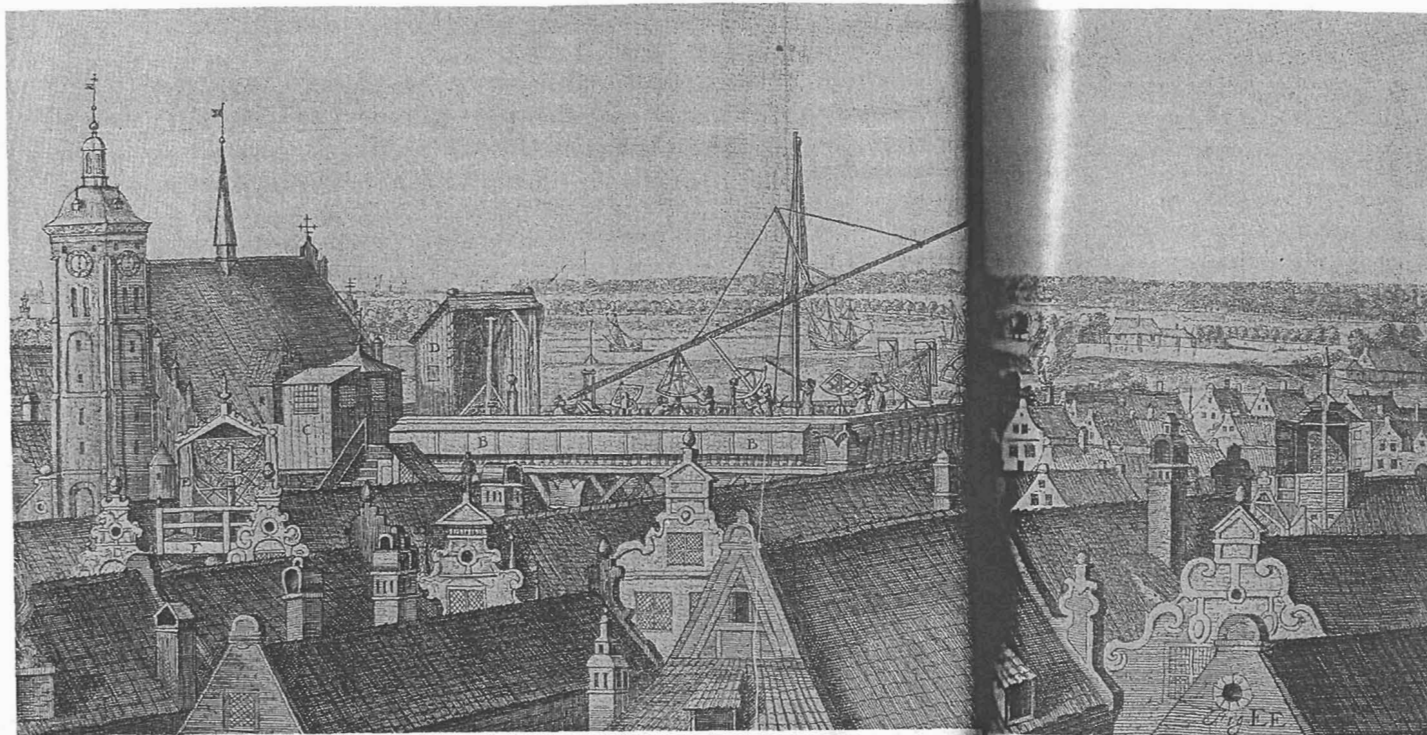


FIG. 1.10. Hevelius's "Civic Stellaeburg" in Danzig (now Gdansk). Hevelius's city building housed every device needed for an astronomer, from telescopes and lens-making equipment to a printing house. He sought to guarantee the credibility of his printed representations by doing all the corresponding activities, from observing to engraving, himself. His success was mixed. Still he needed imperial privileges to forbid other printers' "frauds"; and astronomers like John Flamsteed felt able to cast doubt on his accounts of these processes. Hevelius, *Machina Caelestis*. (By permission of the Syndics of Cambridge University Library.)

and similar régimes. They had good reason to do so. Those systems were deemed necessary to guarantee trust, order, and propriety in their craft.⁵⁹ Livelihoods therefore depended on them. A new understanding of these measures is needed. It must acknowledge their use to suppress texts of which the state disapproved—a use that was certainly real, but that included publications discreditable for reasons of piracy as well as of sedition or obscenity. But it must also appreciate the obverse of this function: the central role contemporaries ascribed to such systems in the maintenance of any trust at all in the realm of print. Printers were "mechanicks," as much in need of "licensing" as preachers (especially "mechanick" preachers) and medical practitioners (the analogue here being "empiricks"). For similar reasons, the book trades themselves participated in their own regulation.

Some went further still. They proposed ways to change the very nature of the printing enterprise and to transform the character of its practitioners.

59. Eisenstein, *Printing Press*, 442. It is also significant that early modern images of the press showed a greater diversity than recognized by Eisenstein. Eisenstein shows only the complimentary iconography of Prosper Marchand ("The press descending from the heavens"); we need also to remember the devils chasing each other through the printing house portrayed in Huss's *La Grante Danse Macabre*, and broadsheets mocking those who believed anything produced by the press. Something of this iconographic range is reproduced in chapter 5 below. For an example of the importance of Catholic censorship in astronomy, see Gingerich, "Censorship of Copernicus."

There were ambitious attempts to establish a non-"mechanical" printing house for learned work, for example. In England the most notable such effort was Archbishop William Laud's at Oxford. Inherited by John Fell at the Restoration, Laud's initiative was eventually secured as Oxford University Press.⁶⁰ The appointment of quasi-genteel "patentees" was, as chapters 3 and 4 show, an even more ambitious strategy to change the very nature of printing so as to eliminate problems of discredit. Patentees were wealthy printers or booksellers—or even gentlemen from outside the trade altogether—to whom the crown granted exclusive rights to key titles, or indeed to whole classes of publication. One patentee held the right to all law books, for example; another held that to all bibles. It was reckoned that they and their books would be securely trustworthy by virtue of their gentility and their dependence on royal favor. In the eyes of some, they could become a model for a future realm of print guaranteed by a decreed civility. Perhaps an urban equivalent to Tycho's civil press—or at least, to Hevelius's at Stellaeburg—could be constructed (fig. 1.10).

60. Ward, *Oxford University Statutes*, I, 205–6, declaring that an *architypographus* must be appointed so that "sordid and vulgar artizans may not pervert the indulgence of that most clement prince [Charles I] to their own private lucre . . . experience has shown [that] these mechanical artizans . . . pay the least possible attention to calligraphy, or the beauty or elegance of the work, but thrust into publication any works, however rude and incorrect."

To the early modern world, then, the character of the printing house and the civil order in which printed books could be accorded trust were interdependent. Bookshops too were places encouraging novel interactions, as indeed were institutions such as the Royal Society. Throughout this book close attention is therefore accorded to the details of such locations. Readers will be led down the darkest alleys of London, and guided through homes and workplaces to reveal their characters with an intimacy few early modern gentlemen can have shared. But here, it may be thought, crouches a paradox. Does the importance of print not lie precisely in its ability to transcend such local contexts and enable communication across wide distances? Surely such a close focus on individual locations risks obscuring this, the most consequential issue of all. It is a real question, with implications beyond the understanding of print alone. The next section addresses this apparent paradox, and from a correspondingly broad perspective. For a central theme of *The Nature of the Book* is to see this power to transcend place as something itself in need of explanation.

PLACE, PRACTICE, AND KNOWLEDGE

Books are a load of crap.

PHILIP LARKIN, "A Study of Reading Habits," *Collected Poems*, 131

The Nature of the Book concentrates for the most part on one country, England, and in particular on its capital city, London.⁶¹ The focus is by no means exclusive, and in fact discussion does extend across Europe as appropriate. Nevertheless, the question must arise: why? The choice may appear arbitrary. More to the point, it may seem perverse to address questions of the identity and consequences of print by examining *any* one location, when the very essence of print, supposedly, is that it enables human beings to transcend their immediate circumstances and communicate reliably with others in different times and places. These are important questions. One plausible answer to the first derives from the extensive attention that historians have directed at the emergence of polite commerce in Augustan England.⁶² As part of this, England became one of the earliest nations to de-

61. Strictly speaking, from the early eighteenth century Britain succeeded England as the political entity in question. Since my discussion covers a long period before union, and in any case concentrates on the region around London, I have generally referred to England here. The issue of national identity was a charged one, however, as has been brought to the fore in such recent studies as Colley, *Britons*; Russell, *Fall of the British Monarchies*; and Morrill, *Nature of the English Revolution*, 91–117.

62. The most recent and comprehensive survey is the massive three-volume series formed by Brewer and Porter, *Consumption and the World of Goods*; Bermingham and Brewer, *Consumption of Culture*; and Brewer and Staves, *Early Modern Conceptions of Property*.

velop a sophisticated commercial culture of printing and publishing, and its concepts of authorship, liberty of the press, and intellectual property have been of influence across the world. It warrants attention for that reason alone. But a further justification may also be advanced—one that addresses the more fundamental question of why it is appropriate to focus on any one location at all.

This book concentrates on the implications of printing for knowledge, and for knowledge of nature in particular, for reasons already outlined. It does so at what was undeniably a time of extraordinary creativity in the history of science. Early modern England witnessed not only the invention of experimental philosophy and the advent of the Royal Society, but the achievements of such figures as Francis Bacon, William Harvey, Robert Boyle, and Isaac Newton. *The Nature of the Book* aspires to address some of our founding assumptions about how such successes were attained. To do so, it concurs with much current work in the history of science in relating knowledge to its particular social and cultural settings. The universality of science, such work suggests, is an achievement realized only through much hard work. That work is necessarily specific to its particular sites, be they medieval universities, Renaissance courts, or Victorian laboratories.⁶³ Such are the places that have harbored the kind of skilled practices through which knowledge has been created and sustained. From this perspective, museums, laboratories, and royal palaces are seen as not just architectural structures, but distinct social spaces generating different practices fertile of new knowledge.⁶⁴ The knowledge fashioned in such places answers the needs of the moment, addresses the questions of the time, and satisfies the standards of the local culture.

For the historian, print and science share a rather intimidating characteristic. Both appear to transcend place. Scientific knowledge, it has been asserted, is by its very nature true wherever one may find oneself. That is what constitutes its claim to objectivity.⁶⁵ Print seems blessed by a similar

63. See especially: Shapin, "House of Experiment"; Biagioli, *Galileo, Courtier*; Hannaway, "Laboratory Design"; Westman, "Astronomer's Role"; Ophir, Shapin, and Schaffer, *Place of Knowledge*; Outram, "New Spaces in Natural History"; Moran, *Alchemical World of the German Court*; Smith and Agar, *Making Space for Science*. For the importance of localization in the history of the "scientific revolution," see also Porter and Teich, *Scientific Revolution in National Context*, and Schuster, "Scientific Revolution," 223–4. Jardine's *Scenes of Inquiry* lucidly explains the philosophical issues at stake.

64. De Certeau, *Practice of Everyday Life*, 117. Elias's treatment of the royal court, for instance, illustrates how it merged family and government in a coherent figuration: Elias, *Court Society*, 1, 41–65; Foucault, "Space, Knowledge, and Power."

65. Ophir and Shapin, "Place of Knowledge," 3–4; Porter, *Trust in Numbers*, 217–9 (which notes the widely cited certificate of science's universality, that "the same textbooks can be used all over the world"); Johns, "Ideal of Scientific Collaboration."

transcendence: in many historians' hands, it appears to hint at something floating apart from specific, compromised, adulterated actuality. Just as appreciations of science have too often eschewed attention to the detailed intricacy of knowledge in the making, so cultural historians' appreciation of print has too frequently stopped short at the doors of the printing house.⁶⁶ But if the universal character of science can be appraised as an achievement, warranted and maintained by situated labors, may the same not be true of print? The suggestion is at the core of this book's approach. Searching for print culture in the making, we actually zero in not just on London, but on particular streets, buildings, floors, and rooms. We shall try to recover the identities, representations, and practices of the people who lived and worked in those rooms. And we shall see how hard they worked to create the realm of print, in a complex and unforgiving web of such domains. The close attention paid by *The Nature of the Book* to the intricate details of individuals' practices, characters, and motivations, far from being peripheral, is thus essential. Such a focus must be adopted in order to show how print, like scientific truth, attains the level of universality—by the hard, continuous work of real people in real places.

This makes the conjunction of the history of print with that of science especially intriguing. The juxtaposition becomes only more curious when one recalls the enormous—perhaps even defining—role that historians have almost unconsciously ascribed to print in the history of science. That history is routinely represented in terms of a chronological skeleton, the joints of which are dates such as 1543, 1632, 1687, 1789, 1859, and 1905.⁶⁷ These years are etched in the memory of every historian of science with a permanence no others can match. They seem ineluctable. Novel historiographical approaches leave them unscathed. And all, of course, are publication dates, ranging from Copernicus's *De Revolutionibus* (and Vesalius's *De Humani Corporis Fabrica*) to Einstein's revolutionary paper introducing special relativity. To that extent, the history of print and that of science are tacitly acknowledged to coincide. Yet, strangely, recent historiography has implicitly directed attention away from the conjunction. The reason for this apparent paradox is subtle, and even rather profound.

There is a sense in which the history of early modern science no longer exists. Historians now employ all the resources of cultural and social histo-

66. This could not be said of bibliographers, but then these have often been too modest in their historiographical objectives. Historians of the book such as Henri-Jean Martin are a more consequential exception, for which see above, pp. 28–30.

67. The dates of Copernicus's *De Revolutionibus*, Galileo's *Dialogo*, Newton's *Principia*, Lavoisier's *Traité Élémentaire de Chimie*, Darwin's *Origin of Species*, and Einstein's "Zur Elektrodynamik bewegter Körper" respectively.

riography in an attempt to explain why people made certain claims in certain circumstances, and why they were or were not believed; whether or not such claims are, to modern eyes, "scientific" has ceased to seem so important. Indeed, although the early modern world recognized something it called "science" (or, more likely, the Latin *scientia*)—namely, the kind of demonstrative knowledge produced by geometers or infallible logicians—it did not acknowledge anything like the modern enterprise. And it certainly did not harbor any *scientists*.⁶⁸ The consequences of accepting this prove substantial. The extent of acceptable topics has widened enormously. Movements previously assumed peripheral—Jesuit philosophy, for example, or, perhaps most spectacularly, hermeticism—have been reassessed as powerful and authoritative in their particular settings. More canonical subjects have also been transformed. Experimental philosophy and Newtonianism, in particular, are no longer seen as gaining straightforward victories over self-evidently inferior opposition. On the contrary, they are seen as struggling for credibility in a cultural bazaar filled with more different candidates for natural knowledge than had ever existed before, offering greater potential rewards. Their proponents' strategies must accordingly be understood as developing in response to these formidable and effective opponents. As they did so, they themselves diverged; it is difficult now to identify any one thing to call "Newtonianism." An appreciation of the viability of alternatives has thus had enriching implications for our understanding of the canonical successes of the "scientific revolution" too.⁶⁹

But this appreciation of a far wider range of places and practices has also had its costs. If natural knowledge was such a localized thing, then the processes by which it came to be transferred from place to place become rather mysterious. Talk of diffusion or dissemination will not now pass muster. The evocation of an all-powerful central source from which influence spreads across an inert terrain is no longer tenable, because sites of reception previously supposed passive are now recognized to have been vital, dynamic, and appropriative. Notions of "popularization" become equally problematic, since they too generally posit audiences as passive receptacles of influence rather than positive agents of appropriation.⁷⁰ With respect to

68. For the origins of the latter term see [Whewell], review of Sommerville's *On the Connexion of the Physical Sciences*, 58–60, and Ross, "Scientist," 71–5.

69. Dear, "Jesuit Mathematical Science"; Henry and Hutton, *New Perspectives*; Hanaway, *Chemists and the Word*; Webster, *From Paracelsus to Newton*; Schaffer, "Newtonianism." For other rehabilitations see Feingold, *Mathematician's Apprenticeship*; Gascoigne, "Universities and the Scientific Revolution"; Gascoigne, "Reappraisal of the Role of the Universities"; Feldhay, "Knowledge and Salvation"; Feldhay and Elkana, *After Merton*.

70. An excellent alternative is presented by Secord, "Science in the Pub." See also Latour, *Science in Action*, 132–44.

knowledge based in experiments the problem is especially evident. The transfer of this particular species of practical, performative knowledge to different sites could never be straightforward, if only because the replication of the localized skills in which such knowledge was based proved riddled with difficulties. Early modern experimentalists knew this all too well; it has only recently been rediscovered by historians. But what was most flagrantly true for experimental knowledge was also true, if less obviously, for other claims to epistemic authority.

Here lies another reason to focus on England. In London, the Royal Society (chartered in 1662) pioneered solutions to these intractable problems. In part it did so by aggressive intervention in the realm of print. A long-term consequence was a transformation in both print and natural knowledge. Indeed, one of the most interesting and unusual aspects of Restoration experimental philosophy was that it explicitly confronted this situation. Robert Boyle and his colleagues at the Society recognized it remarkably early, and advanced notably cogent solutions. One aspect of their responses is well known, and has been extensively analyzed of late. For all its difficulty of achievement, experimental philosophers appealed to replicability as testament to the truth of the knowledge they professed. In one sense, that very difficulty was an asset: it helped make successful repetition in different cultural settings a robust criterion of truth. The result was a claim about replication that has become central to the authority of modern science. But the character of the obstacle to replication also deserves note. As has become well known, successful repetition of an experiment elsewhere often required the transfer of more than just written or printed materials alone. Extensive social contact between practitioners was needed in order to reproduce cultural skills and settings in a new site. A skilled practitioner might even have to travel in person between the two locations in order for the attempted replication to succeed—or, for that matter, for it definitively to fail. It thus seems that nobody in 1660s Europe built an air-pump successfully by relying solely on Boyle's textual description of the engine. Some, we know, tried; all, we think, failed.⁷¹

A key assertion of the sociology of knowledge has been that this is true not just in practice, but in something approaching principle. Experimental knowledge of the kind sought by Restoration natural philosophers must necessarily be founded in skills, the character and application of which can never be stipulated exhaustively by written rules. Replication requires the re-creation of a performative and interpretative culture in which candidate attempts can be conducted. Building new air-pumps could indeed be done

71. Shapin and Schaffer, *Leviathan and the Air-Pump*, 229–30, 235.

from recipe-like textual instructions, but only if interpreted in a shared recipe-reading culture. That is one reason why such knowledge seems to be inescapably social: it depends on the face-to-face interactions that help constitute such a culture.⁷² It is also why some historians of science have directed their attention away from what they think of as “texts.” These are not, they suppose, the prime building blocks of either society or knowledge.

Yet there must be more to say about the importance for the construction of natural knowledge of the construction of print. Early modern natural philosophers did make and use a variety of written, printed, and engraved objects. They labored over books, periodicals, letters, “schemes,” and any number of similar textual and pictorial materials. They expended very large amounts of time and money doing so—larger, as chapter 7 will show, even than those expended on experimental instruments like the air-pump. Even the most basic historicist sensibility is likely to rebel at the thought that all this activity was intrinsically futile. In fact, it is possible to argue that it was central to enterprises dedicated to making knowledge—even experimental ones.

Several historians have already noted that experiments often did not, in fact, need to be replicated at all. Rhetoric helped.⁷³ Boyle and his interlocutors developed sophisticated and prolix ways of writing reports of their experimental trials. By stating explicitly every circumstance of the experimental scene, a report sufficiently crammed with detail could aspire to persuade distant readers that they had as good as been there themselves. In that event, they effectively became “virtual witnesses” to the experiment itself. Such virtual witnessing could thereby render the actual practice of replication largely otiose. The skills of an experimenter may indeed have demanded complex cultural modes of transfer and appropriation, then, in which texts were not omnipotent (fig. 1.11). But if “texts” were ineffective for transmitting manual skills, more tangible objects could be put to use to mediate the creation of consensus by means of recruiting readers. Books, periodicals, papers, letters, maps, graphs, and diagrams did move back and forth between sites, proving extremely useful tools for the making and maintenance of knowledge. Rhetoric, however persuasive, came into being and achieved its effects only when incarnated in such objects. Historians of science need

72. Collins, *Changing Order*, 55–7, 70–73, 77; Gooding, Pinch, and Schaffer, *Uses of Experiment*, 10–13; Lynch, *Scientific Practice and Ordinary Action*, 211–4. Compare Lawrence, “Incommunicable Knowledge,” for tacit knowledge in the history of medicine. Eamon, *Science and the Secrets of Nature*, is the most recent work to concentrate on recipe-like texts: see esp. 130–33.

73. Dear, “*Totius in Verba*”; Dear, *Literary Structure*; Gross, “Rhetorical Invention”; Bazerman, *Shaping Written Knowledge*; Moss, *Novelties*. For “virtual witnessing,” see Shapin, “Pump and Circumstance,” and Shapin and Schaffer, *Leviathan and the Air-Pump*, 22–79.

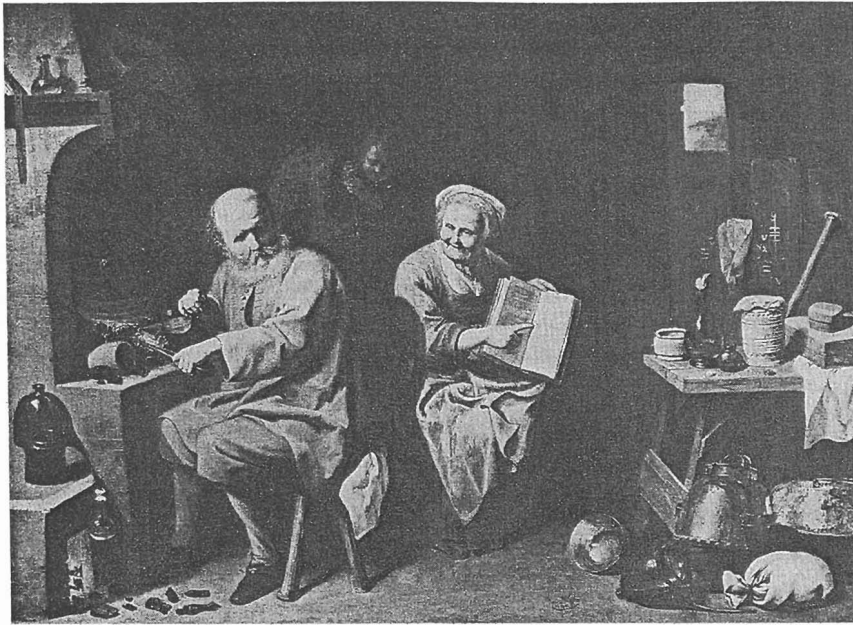


FIG. 1.11. Reading skills juxtaposed with experimental dexterity. David Ryckaert III, *The Alchemist* (1648). (By permission of the Syndics of Cambridge University Library.)

to begin considering in detail their processes of manufacture, distribution, and use.⁷⁴

Use in particular is important here. It raises rather a subtle issue, hinted at in general above but now requiring explicit attention. Almost all historians put themselves in the place of early modern readers and assume that their own act of reading replicates that of their historical counterparts. But this substitution may not be entirely innocuous.⁷⁵ A rather different approach is suggested if one identifies reading itself as a skill, just as historically specific as the more obvious dexterity involved in experimentation. If reading has a history, then assuming that modern readers' responses to a printed page accurately reproduce those of seventeenth-century men and women becomes problematic. Attendance to the conventions constraining the appropriation of printed objects in particular historical settings seems much more pertinent. Agreement across cultural spaces arose out of the exercise of such reading skills. Rhetoric, however expert, depended on them. The ques-

74. There are exceptions. Golinski, *Science as Public Culture*, and Stewart, *Rise of Public Science*, largely escape this charge by paying close attention to contexts of use.

75. Chartier, *Pratiques de la Lecture*, 7; Chartier, *Cultural History*, 40.

tions addressed in *The Nature of the Book* are of a correspondingly specific order: of how an experimental paper was actually composed by *this* writer, made by *these* workmen, distributed by *these* merchants and diplomats, and discussed in *these* ways, by *these* people, *here*, in *these* circumstances, with *these* results. This very minuteness of focus enables it to trace a grand process: the elaboration of a print culture and a culture of natural knowledge in tandem.⁷⁶

Chapter 6 pursues this specificity to its most intimate level. It examines how early modern people represented reading itself, in terms of their very minds and bodies.⁷⁷ Directing attention to the human frame, it asks how readers sought to understand their experiences in terms of its "passions." The implications of their quest extended very widely indeed: from the fortunes of Protestantism to the transmutation of metals, and from the education of gentlemen to the development of women's authorship. It also impinged directly upon their responses to Creation. Investigating the "book of nature" was thus a profoundly reflexive process: early modern people arrived at natural knowledge through reading, a skill that they in turn understood in terms of the natural knowledge so gained.⁷⁸

Recognition of the ineffable character of skill thus need not imply that print is a peripheral subject for the historian of science. On the contrary, in the future we shall need to marry the two. The history of reading suggests one way to do so. The salience of printed books and papers cannot now simply be exorcised by alleging the inability of texts to determine their readers' conclusions; that they were unable to force concurrence does not

76. Gingerich and Westman are among the few historians of Renaissance science to have consistently attended to the entire history of books, from writing to reading: e.g., Gingerich, "Copernicus's *De Revolutionibus*"; Gingerich, "Censorship of Copernicus"; Westman, "Proof, Poetics, and Patronage"; Westman, "Reception of Galileo's *Dialogue*"; Gingerich and Westman, *Wittich Connection*. William Eamon, although his work centers on books, does not generally venture into such details: see especially his *Science and the Secrets of Nature*, and also his "Books of Secrets"; "Arcana Disclosed"; "From the Secrets of Nature to Public Knowledge"; "Court, Academy and Printing House." Rostenberg's *Library of Robert Hooke* is another recent exception to the rule, but one riddled with errors.

77. See also Johns, "Physiology of Reading in Restoration England" and "Physiology of Reading and the Anatomy of Enthusiasm."

78. Shapin, *Social History of Truth*, xviii–xix. For the image of the Book of Nature, see Eisenstein, *Printing Revolution*, 455–6, 471–8; Brooke, *Science and Religion*, 75–81; Blumenberg, *Lesbarkeit der Welt*; Findlen, *Possessing Nature*, 55–63 (much the most interesting recent set of remarks on the subject in English); Dingley, *Vox Caeli*, sigs. [A5^r]–[A6^r]. For shifts in the modern significance of the metaphor, see also Traweek, *Beamtimes and Lifetimes*, 160–1. Nehemiah Grew referred to John Wilkins holding the Bible in one hand and Grew's own book—some pages from the book of nature—in the other, as a commentary on the first, "by which, in part God reads the World his own Definition, and their Duty to him": Grew, *Anatomy of Vegetables Begun*, sigs. A4^r–[A7^r].

mean that such objects were not interpreted at all. The reading of a book is no less skillful, and no less local, than the conducting of an experiment.⁷⁹ To understand the transformation of science into an apparently universal culture, then, we need to create a history of the reading practices surrounding scientific books as detailed and intricate as the appreciation we already have of the experimental practices surrounding scientific instruments. *The Nature of the Book* marks the beginning of that enterprise.

NATURAL KNOWLEDGE IN ENGLAND:
WISDOM IN THE CONCOURSE

Wisdom crieth without; she uttereth her voice in the streets: She crieth in the chief place of concourse, in the openings of the gates: in the city she uttereth her words, saying, How long, ye simple ones, will ye love simplicity? and the scorners delight in their scorning, and fools hate knowledge? Turn you at my reproof . . . But ye have set at nought all my counsel, and would none of my reproof: I also will laugh at your calamity . . . For the turning away of the simple shall slay them, and the prosperity of fools shall destroy them.

PROVERBS 1: 20–32

Translating the experiences of Galileo and Tycho into the rather different situation of late Renaissance England is not a straightforward task. The courts of Elizabeth, James I, and Charles I never attained the culture of absolutism surrounding those of Rudolf or Cosimo—much though they may have tried—and there was no official court philosopher here.⁸⁰ Yet in some ways English natural philosophy disputes were modeled on such Continental forms. Books and manuscripts played just as central a role in English courtly life, and perceptive historians have noted the extent to which those presented at court might be assumed to bear the patron's authorship.⁸¹ Nor did this courtly role end with the Civil War. As we shall see in chapter 8, as late as 1712 not one of the four hundred copies printed of John Flamsteed's

79. See especially Chartier, "Culture as Appropriation"; Chartier, *Pratiques de la Lecture*; Chartier, *Lectures et Lecteurs*; Chartier, "Texts, Printings, Readings"; Chartier, *Passions of the Renaissance*, 1–11, 110–59, 326–61, 362–95; Martin, "Pour une Histoire de la Lecture"; de Certeau, *Practice of Everyday Life*, 165–76; Cressy, *Literacy and the Social Order*, 1–18; Darn-ton, "History of Reading."

80. The nearest equivalent was John Dee, as attested in the possibly sarcastic remarks of real courtiers: Sherman, *John Dee*, 7–8; Roberts and Watson, *John Dee's Library Catalogue*. See also above, note 36. Compare Harriot, who made similar observations to Galileo's but was unable to make them count: Jacquot, "Thomas Harriot's Reputation"; Henry, "Thomas Harriot and Atomism"; Cormack, "Twisting the Lion's Tail."

81. Goldberg, *James I and the Politics of Literature*, e.g., 1–9. James I had visited Uraniborg itself: Thoren, *Lord of Uraniborg*, 334–5; Brahe, *Opera*, II, 11–12.

Historia Cœlestis—the greatest work of observational astronomy then in existence—seems actually to have been sold, but volumes were distributed through diplomatic channels across Europe and as far as Muscovy. Flamsteed, like Tycho in Prague, held the title of royal astronomer, and chapter 8 will show the extent to which he modeled every aspect of his conduct on Tycho's. But the difference between English and imperial natural knowledge may be measured by his failure. Although his observatory on Greenwich Hill more than matched his predecessor's Uraniborg for the accuracy of its instruments, Flamsteed had no private printing house. For him, the consequences were to prove calamitous.

In England, there was no noble Tycho Brahe able to boast his own autonomous printing operation. There was no way in which the production of learned books could be taken out of commercial hands. Philosophers could not hope to emulate Tycho's success—partial and compromised though even that success was—because they had to live and work in an environment of city and court in juxtaposition. They had to reconcile civility with commerce. They had to utter their wisdom in the streets of London, where its reception would be far from secure. The first thing to appreciate about the articulation and reception of natural knowledge in early modern England is its insecurity. The achievements of the Royal Society were consequently but one element in a continuing history of attempts to discipline print and render it a sound platform for building a godly nation. That history included the development of vital and lasting new concepts of authorship, publication, and reading.

A series of proposals for the reform of knowledge and its circulation grappled with this situation. Most influential were the ambitious schemes put forward by James I's lord chancellor, Sir Francis Bacon. Bacon's identification of a trinity of transforming inventions—compass, gunpowder, and press—is, of course, famous. It is often assumed from this proclamation that Bacon recommended the open printing and publication of knowledge to aid in its advancement. Yet this is a misapprehension. Bacon in fact represented the printing press as a prime example of how inventions should *not* be sought. He believed that there was "nothing in the art of printing which is not plain and obvious." Speaking to Queen Elizabeth through the personified figure of Natural Philosophy, he called the press "a gross invention," which had been not so much invented as "stumbled upon and lighted on by chance."⁸² And he certainly did not recommend unrestricted publication of knowledge, urging rather its retention within a tiny community of

82. Martin, "'Knowledge Is Power,'" 97–103; Martin, *Francis Bacon*, 64–8; Bacon, *Works*, IV, 100, 113–5. However, in the *New Atlantis* the (anonymous) inventor of printing did merit a statue in the gallery of inventors: *ibid.*, III, 165–6.

royal licentiates. Both opinions derived from his view of the purpose and organization of knowledge. Bacon aimed to make natural philosophy a sector of the state. Regarding himself primarily as a statesman and royal counselor, he wished to establish an administrative mechanism for generating natural knowledge that would best serve the advancement of the crown. The best natural philosopher, in this vision, would be the best state official. His greatest targets in proposing this scheme were thus what he called “voluntaries”: individuals who claimed a right to profess knowledge independent of the state’s bureaucracy.⁸³ In order to eradicate such dangerous knowledge-peddlers, it would be necessary to “purge the floors of men’s understandings,” and to replace their independent notions with rigid, unified rules of operation. “The business,” he decreed, “must be done as if by machinery.” The press was the exception that proved this rather daunting rule. It was a device discovered by chance, and by disorganized artisans. Yet it had prospered, and the commonwealth had profited by its success.

Or had it? True, there were many new books to be read; but this did not mean that they conveyed any more genuine knowledge. Bacon urged that his bureaucracy create new editions of classic authors, “with more correct impressions, more faithful translations, more profitable glosses, more diligent annotations,” the implication being that the creations of the press were at present profoundly *unsatisfactory*. Besides, open printing encouraged dangerous ambitions. Bacon therefore insisted that his own proposals be known only to “some fit and selected minds,” and that the knowledge produced by his state machinery be similarly guarded. In the *New Atlantis*, his grand vision of a political state founded on natural knowledge, the personnel of Solomon’s House were required to take an oath of secrecy. Only three selected individuals were allowed to be “Interpreters of Nature.” The governors would authorize only approved conclusions to be made public on their periodic “circuits.” And the deep knowledge on which their useful promulgations were based would never be revealed at all.⁸⁴

A problem of authorship thus coincided with that of knowledge. In Bacon’s era, ambitious treatises of natural knowledge were being written by an unprecedented multiplicity of writers: not only royal counselors, but lawyers (like Bacon himself, and later Sir Matthew Hale), mathematical practitioners (like Robert Recorde, Sir Henry Billingsley, Robert Norman, and Thomas Digges), university scholars (like Nathaniel Carpenter and John Wallis), churchmen (like John Wilkins and Seth Ward), and physicians (like William Harvey, William Gilbert, and Robert Fludd). Soon women like Margaret Cavendish would be added to their number. What was their claim

83. Martin, *Francis Bacon*, 56–63, 121–6, 150, 163, 173.

84. Bacon, *Works*, III, 165–6, 323–5; Martin, *Francis Bacon*, 149–51, 163–4. Contrast the portrayal in Elsky, *Authorizing Words*, 200–4.

to legitim cy in so acting? How were their arguments properly to be resolved? Ironically, all claimed to offer unity and an end to the discord inspired by the very proliferation of voluntaries in which they themselves participated. Even natural magicians, conventionally identified as worst of voluntaries, tried to establish their credentials as bringers of order by waxing indignant at the “cavilling, brabbling” and seditious scholastics.⁸⁵ Whether expressed as ridicule or hostility, opposition to illegitimate authorship became a pervasive feature of English writing on the natural world.

Bacon’s was a forthright statement of one ideal for the determination of disputes in natural knowledge. It effectively envisaged an English social equivalent of Uraniborg. All practitioners must be licensed by court officers, resolution of arguments must be centralized and decisive, word of the debates must be restricted to the central legislators, and there must be no publication to the populace without central approval. Printing, dispersal, and reading of books were to be monitored by a privileged élite according to its civil conventions. For a Jacobean counselor it was a tempting prospect. And it would be repeated in various forms by successive systematizers later in the century. Gabriel Plattes’s proposed state “Laboratory,” for example, would admit only someone prepared to stay inside “till he be brought forth to go to the Church to be buried.” Even this seemed mild compared to Macaria, where anyone dispersing unlicensed opinion would, quite simply, be executed.⁸⁶

But although Tycho’s isolation was tempting, it was not achievable. Courtly aspirations notwithstanding, in England there would always be other printers, booksellers, writers, and readers at work. The fact was that book dispersal did not operate entirely through diplomatic and courtly channels. There was a national and international book trade, and before long even books directed at restricted audiences—including, as already observed, both Tycho’s and Galileo’s—participated in it. Courts were continuously being reminded of the unpredictability (and worse) that could result, and again England’s was no exception. If the propriety of disputes was that of the court—or, for that matter, the university—then the very involvement of the book trade introduced an important new element. It was not necessarily disastrous; Galileo, after all, embraced this realm for a while with

85. For a particularly insistent example see Fludd, *Mosaicall Philosophy*. Fludd raised the denial of controversy into an ontological principle, insisting that all apparent contrariety in the natural world must be referred to the undivided action of God; the quarrels of scholastics, he thought, corresponded to their idolatrous respect for natural oppositions such as antipathies.

86. Plattes, “Caveat for Alchymists,” 87; [Plattes], *Description of the famous Kingdome of Macaria*, sig. B2^r (contrast the misleading impression given in Eisenstein, *Printing Press*, 305, which is often repeated by historians). Winstanley made preaching for hire one of the few capital offenses in an ideal society: Hill, *Turbulent, Seditious and Factious People*, 338.

creativity and skill. But it was definitely threatening. Printing and bookselling were concentrated almost exclusively in the vast social morass of London, a city represented by most courtiers and scholars as incipiently rebellious and fascinatingly venal. As would-be authors complained, Wisdom might find as heedless an audience in these streets as in those of Old Testament times.⁸⁷ Philosophers would be forced to see the problem with particularly stark clarity.

We cannot say how Galileo would have fared had he been an Englishman. The nearest equivalent to his struggles in Rome and Florence, however, was a controversy over Copernicanism and related issues that occurred in 1634–46 between Alexander Ross and John Wilkins. Wilkins indeed took the *Sidereus Nuncius* as his model, reproducing one of its images of the Moon.⁸⁸ But the differences between the two cases are as revealing as the similarities. There was scant trace in this dispute of Tycho's sterilized way of printing and distributing texts, and of Galileo's recourse to court conventions. Wilkins's initial tract was anonymous, and was displayed in the shop of the most incendiary Puritan bookseller in London, Michael Sparke, who had earlier introduced Tycho himself to the London public in the guise of a Protestant millenarian prophet (fig. 1.12).⁸⁹ Sparke's was the most prominent name on the title page. His notoriety, like that of Galileo's bookseller in Rome, fueled the conflict. Ross did attempt to use the issue for preferment in the church, but with minimal success. He ended up a bookseller's hack, churning out pedantic diatribes against every original thinker of the time. Neither writer managed to gain an audience at court, if that was their aim. In a sense, neither achieved authorship at all.

The aspiration to authorship, however, stood at the center of the Wilkins-Ross dispute, just as it had of Bacon's concerns. It was expressed as a mutual repudiation of the illegitimate "singularity" displayed by those who boasted, not reasoned knowledge, but passionate "fancy." Reconciling aspiration with credit was clearly difficult. To assert originality while avoiding the taint of singularity became a central problem for writers in all fields.

87. Abiezer Coppe, for one, put himself in the place of Wisdom: Mack, *Visionary Women*, 105. For later uses of the text, see Vincent, *Literacy and Popular Culture*, 174–5.

88. [Wilkins], *Discovery*; [Wilkins], *Discourse*; Ross, *Commentum de Terrae Motu*; Ross, *New Planet no Planet*. The standard treatment remains McColley, "Ross-Wilkins Controversy," but see also Johns, "Prudence and Pedantry." Ross seems to have been an early example of the professional author, paid by booksellers like Richard Royston to produce tracts for popular sale. See Glenn, *Critical Edition of Alexander Ross's 1647 "Mystagogus Poeticus,"* 625. His role should be compared to that of the Dominican Tommaso Caccini in Galileo's struggles: Finocchiaro, *Galileo Affair*, 28–9, 136–41, 282; Blackwell, *Galileo, Bellarmine*, 112–6.

89. Brahe, *Learned Tico Brahae his Astronomical Conjectur*.

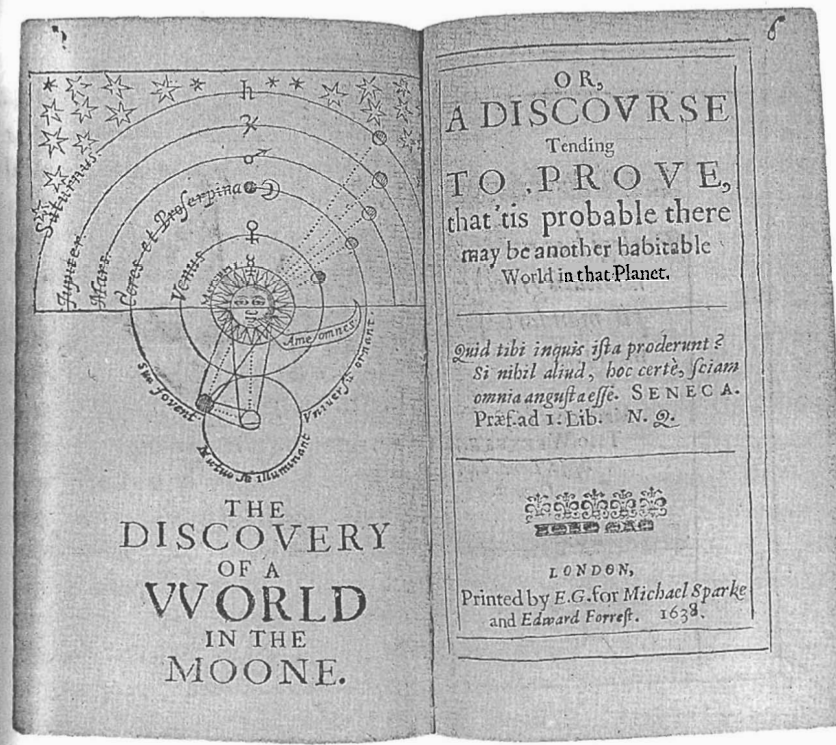


FIG. 1.12. [Wilkins], *The Discovery of a World in the Moone*. Frontispiece and title page. (By permission of the Syndics of Cambridge University Library.)

Some simply listened to the advice of their peers, and kept silent. Others relied on a flourishing and successful manuscript distribution system to evade the charge.⁹⁰ Still others, like Wilkins himself, chose to insist upon a "Philosophical Liberty" to suggest (but not to insist upon) ideas at variance with those espoused by received authorities. Geographer Nathaniel Carpenter actually funded his own printing and publication.⁹¹ Wilkins took a further step, and ingeniously appropriated the conventions of modesty to avoid the charge of singularity. A writer must display hesitancy and probability, not a stentorian insistence on the certainty of his ideas, in order to reconcile credit with authorship. Doing so, one could avoid the trap of "boldness" into which singular authors invariably fell. Modesty could hold the commonweal together. Wilkins thus argued that Ross's "singularity" encapsulated at once his "conceit" for his own ideas, his "servile and superstitious" attitude to authority, and his slavery to "sense" rather than "discourse and

90. Love, *Scribal Publication*; Woudhuysen, *Sir Philip Sidney and the Circulation of Manuscripts*, 27–203, 224–41.

91. Davis, "Religion and the Struggle for Freedom," 514–5; Shapiro, *John Wilkins*, 55; Feingold, "Mathematical Sciences," 388–400.

reason.” Wilkins’s opponent was the archetypal “captious” man.⁹² In contrast, Wilkins himself had begun to articulate principles of authorship that historians of science will recognize as characteristic of early experimental philosophy.

Wilkins’s espousal of modesty and a liberty of philosophizing immediately reminds the modern reader of Boyle. But a significant difference exists. Wilkins’s argument extended to questions normally the preserve of the mathematical sciences, not just natural philosophy and natural history. This division—between disciplines devoted to the mathematical representation of phenomena and those characterized by their collection and philosophical investigation—was ancient and persevering. Wilkins was one of several important figures to advocate a novel realignment. But such a transformation was as yet far from complete. One should therefore recall that the specific program of experimental philosophy proposed by Boyle was far from the only candidate for natural knowledge on offer. Even within the Royal Society itself, there were noteworthy alternatives, including various plans for natural and artificial histories, and indeed the “Physico-Mathematicall-Experimentall Learning” recommended by Wilkins himself. Isaac Newton was one contributor who pointed up the differences between Wilkins’s and Boyle’s conventions.⁹³ All, however, from mathematicians to alchemists and from experimentalists to physico-mathematicians, found themselves facing the problems of authorship and reception cast up by contemporary printing. The Royal Society helped all to address those problems, and it did so partly under the aegis of Boylean principles. It is in this context, then, and not just in that of Boylean experimental philosophy itself, that the Society’s experiences of print proved consequential. It is not just that the virtuosi—as the Society’s fellows were widely known—pioneered ways of dealing with print; those ways became central to the fortunes of natural knowledge of diverse traditions.

The Society’s own success has always been signaled by its publishing enterprises—which included the first “scientific” periodical, the *Philosophical Transactions*, and Isaac Newton’s masterpiece, the *Philosophiæ Naturalis Principia Mathematica*. But an account of the role of the book and other printed materials in the Society should end with these, not begin with them. One must first reconstruct the efforts to enact conventions of reading within

92. [Wilkins], *Discovery*, 3; Wilkins, *Discourse*, 136–8, 144, 146–8, 226; Wilkins, *Of the Principles and Duties of Natural Religion*, 138–9, 203–4; Shapiro, *John Wilkins*, 239. Gassendi and Boulliaud also found Ross unimpressive: Mersenne, *Correspondance*, IV, 324–6, 348.

93. Kuhn, “Mathematical versus Experimental Traditions,” 35–52; Dear, *Discipline and Experience*, 2–3, 8–9, 227–43, 245–9; Westman, “Astronomer’s Role,” 116–33; Whitaker, “Culture of Curiosity,” 82–5.

the Society itself, by which incoming books and papers could be handled and, perhaps, published in conditions of civil trust. In its interactions with the book trade, too, the Society worked hard to establish mastery, so that its productions would not be reprinted, translated, or even pirated without its consent. The maintenance of faith in its reports—and therefore in important natural and technical conclusions—depended on its success. Without these conventions it could not have built up and maintained renown as a location in which personal authorship would be safe. Indeed, upon them rested the very possibility of reconciling personal probity with the aspiration to philosophical authorship. Without them even a respected virtuoso might fall victim to a printer’s conduct. “All y^e Stationers” had to be “reduced to better Termes of Reason & honesty,” warned John Beale, an active fellow of the Society. But the Society had to start with its own Printer, who generated “y^e loudest outcrye” of all. “I wish he had subscrib’d his own name, & not mine,” Beale complained after seeing the printed version of one of his papers, for readers would otherwise ascribe its “Phantastical, Imprudent, or Distracted” character to the authorship of Beale himself. “Wee should have more prudence, than to expose our reputations to the humour of such a sordid man.”⁹⁴

Surely, it may be objected, printing may have affected the communication of knowledge, but scarcely its creation. Chapters 6 and 7 challenge this assumption by looking in close detail at the practices of knowledge-making in the Royal Society, and at the notions of reading and representation that underlay them. Chapter 7 in particular addresses the fortunes of natural philosophy. Chapter 8 then extends the scope of this analysis. It proceeds to examine one of the major mathematical sciences, namely astronomy. It demonstrates that not even apparently “raw” empirical observations and rigorously quantitative calculations could escape the implications. To do so it traces in detail the course of an astronomical dispute of central importance to the history of science.

From 1675 Astronomer Royal John Flamsteed worked to construct a catalogue of the positions of the fixed stars. It promised to be the greatest work of observational astronomy ever produced. But by the end of 1712 Isaac Newton, Edmond Halley, and John Arbuthnot had printed and dispersed a text of his work, against Flamsteed’s vehement opposition. The unauthorized volumes presented a radically different view of the role of the astronomer from his own—one implying that he had been sorely deficient as a public servant. Even its apparently objective positional figures had been changed in the course of Halley’s extensive “correction” of the press. The

94. Beale to Oldenburg, 15 March 1669/70: Oldenburg, *Correspondence*, VI, 560–1

chapter shows in detail how booksellers, printers, and natural philosophers combined in alliance to achieve their aims. If they failed, even elementary statements of observation would prove vulnerable. Together chapters 7 and 8 therefore demonstrate the centrality of the issues raised by earlier sections of the book for both philosophical and mathematical approaches to Creation.

One reason Flamsteed suffered was that his observatory stood on Greenwich Hill, several miles distant from the clamor and grime of London. The character of the metropolis itself represents a final reason to focus on England. The unprecedented expansion of London created a unique urban environment with powerful and assertive craft communities. Here, as the Restoration virtuosi always stressed, the creation of natural knowledge must be a collaborative enterprise. It must draw together not just gentlemen, but printers and booksellers too—not to mention the critical readership thronging the coffeehouses. The labor would be long, and it would be hazardous to the good names of all involved. Philosophical writers would have to negotiate all the obstacles facing every other kind of would-be author, including regulatory régimes, piracy, skeptical booksellers, and unruly readers. Printers and booksellers, for their part, would suffer frustration, ridicule, debt, prison, and death. The story of natural knowledge in this period should embrace all their efforts. This book thus proceeds in a trajectory from the printing house and bookshop to the Royal Society and the Royal Observatory: from Joseph Moxon and Francis Kirkman to Isaac Newton and John Flamsteed. It is a valuable realignment. Emphatically, intellectual history cannot be just the history of intellectuals.⁹⁵

Scientific debate as such was unknown in the early modern world. We would be unjustified in artificially selecting what seems to us the “scientific” content of disputes such as that between Newton and Flamsteed in order to explain the successes of some theories, artifacts, and individuals over others. It is scarcely a novel proposition. A vast amount of work has been done to reveal the historical and cultural specificity of such strategies. What is more original is the suggestion that we need to appreciate just how important conventions of propriety in books’ manufacture, dispersal, and use really were in the practice of natural philosophy. Adding this appreciation may result not just in an extension of our knowledge, but in a change to the very essence of our historical perceptions. Early modern London, where the cultural construction of print coincided with the fashioning of experimental philosophy, offers unusually intriguing possibilities for such an approach. So intriguing, perhaps, that it is possible to suggest a still greater implication.

95. Contra Krieger, *Ideas and Events*, 53.

“Do books make revolutions?” asks Chartier, and answers that books themselves do not, but the ways they are made, used, and read just might.⁹⁶ We can rephrase his query to ask, “Do books make *scientific* revolutions?” But the answer may well stay the same.

96. Chartier, *Cultural Origins of the French Revolution*, 85–7.