Part I **Professional science communication**

1 Spreading the word: problems with publishing professional science

One afternoon in January 1693 the sign outside the coffee house at the Blackfriars end of the Strand groaned in the wind howling off the Thames. At half past two the bookseller John Dunton reached the coffee house, quickly moving inside to the fire, candles and scattering of occupants. He paused once the door had closed and spotted Benjamin Steele in a corner. Beside him sat Richard Holden chewing the end of a quill. Dunton greeted them as he sat down, opening his satchel from which a heap of pamphlets and books fell onto the table, each marked with slips of paper. He fished out some blank sheets from the satchel's nether reaches and put them in front of his henchmen.

"Ben, you had best start with this German report. You should be able to run up a draft, then we'll get Harrington to make sure we have it authentic. Richard, the introduction in this botanical tome looks interesting though the Latin is awful. Show me when you've a draft. I can probably make a sensible judgement. Meanwhile I will make a start on this French piece which claims to be a lost essay by Monsieur Descartes. About that, we shall see."

All three set to work drafting English translations of the three pieces of foreign natural philosophy; one cosmological, one botanical, one mathematical. Steele and Holden's threadbare clothes quickly became aromatic and Dunton made extensive use of a strongly scented handkerchief. That was one problem of working with Cripplegate hacks. Another was their greed for payment. They existed on the trifles earned for commissioned work or from selling the odd article to the new commercial magazines.

After an hour's graft, the trio's concentration was broken by the arrival of Harrington D'Arcy, younger brother to Earl Crompton. Although he was a Fellow of the Royal Society, a genuine natural philosopher, D'Arcy joined Dunton and his hacks in putting together the periodical of the learned (but entirely fictitious) Athenian Society. This was the *Athenian Mercury*, a fake that sold better than the genuine *Philosophical Transactions of the Royal Society*. D'Arcy disliked many officers of the Society and wanted the mythical Athenian Society and its *Mercury* to flourish instead. "Any correspondence?" asked D'Arcy. "Of course", said Dunton pulling a bunch of letters from the satchel, "several; you'll enjoy them. You'll be able to contradict Boyle for the chemical enquiry". D'Arcy grinned; he was no fan of the late Robert Boyle.

Another hour's work and most of the next issue of the *Athenian Mercury* was ready. Dunton had made several translations beforehand, Holden had prepared three philosophical letters in the styles of different Royal Society luminaries, and with what they had just translated and D'Arcy's detailed natural philosophical replies to genuine public enquiries, the *Mercury* was virtually put to bed. The fictional Athenian Society turned out excellent philosophical discourse with a ready readership. The *Mercury* was more regular than the halting *Philosophical Transactions* of the real Royal Society.

PROFESSIONAL SCIENCE COMMUNICATION BEGINS WELL, EVEN IF AUTHENTICITY IS DIFFICULT

John Dunton, the Athenian Society and the *Athenian Mercury* are real, Steele and Holden are invented hacks and D'Arcy an invented natural philosopher (at least two actual members of the Royal Society helped Dunton with his fake publication). The hall of mirrors goes

on because, while the Athenian Society was a virtual copy of the real Royal Society, the *Athenian Mercury* was itself imitated by a second-order fake, the *Lacedomonian Mercury*. These two publications poured ordure over each other in print until the *Athenian Mercury* came unstuck when the Tory hack and playwright, Elkanah Settle, sent in a false reader's letter citing a number of learned sources which Dunton took to be genuine and replied in supportive vein. That gave Settle the ammunition to expose the Whig Athenian Society and *Mercury* as lies, which he did in a coruscating satire, the *New Athenian Comedy*. The learned fakes were exposed and disappeared, but their existence demonstrates the ease with which trust in printed material could be undermined by unscrupulous mimics in the uncontrolled print market at the time.

Publishing scientific work for professional natural philosophers (and later scientists) has continued to be difficult; what to present, how to present it and how to ensure that it is published. The Royal Society published the first issue of its proto-learned journal, the *Philosophical Transactions*, in May 1665 edited by Henry Oldenburg, its first Secretary. The journal had a job of persuasion to do as many contemporaries regarded natural philosophy as strange. Adrian Johns has shown that the production of the *Transactions* was anything but smooth, and uncovered the scenario story of the virtual societies and the fake publications. The Royal Society had to establish a reputation for trustworthiness, otherwise natural philosophy would never be accepted. Its decision to allow Oldenburg to launch the *Transactions* was odd. The respectable way to present natural philosophy at the time was in Latin monograph books. Oldenburg was proposing to publish an ephemeral record of 'work in progress' in vernacular language, using the freshly evolved periodical form, a close relative of the tract and the pamphlet, already well established as the home of political cant and pornography. To use a modern analogy, it was as if (say) a society representing new British human rights lawyers decided to publicize their professional activities by publishing an illustrated comic.

So why did Oldenburg suggest such a periodical and why did the Society approve? Johns gives three main reasons. Printers did most of their work on small contracts and preferred limited runs of repeating units (small but regular periodical issues were more attractive than one-off monograph books), books required a much larger capital outlay to set and print (which printers often wanted authors and potential buyers to help finance), and there was gentlemanly distaste for the demonstration of ambition, implied by putting one's name to a large publication. It was much easier for the Royal Society's virtuosi to publish small authored papers because they did not then appear over-pushy.

Oldenburg made a good start with the *Philosophical Transactions*, but things soon began to go wrong. The plague forced the Society out of London in 1666 and the Great Fire of London in the same year nearly ruined the London printers, because they used vaults of old St Paul's Cathedral as storage and most editions went up in smoke along with the edifice itself. Costs, regularity of printing, distribution and sales all went haywire in the later 1660s and 1670s and issues of the *Philosophical Transactions* were pirated, sometimes by the Society's own printers. People were deceived by these imposter versions, which contained different arrangements of items, and were mistranslated on the Continent, severely undermining the Society's reputation overseas.

But the Society's ultimate success with the *Philosophical Transactions* encouraged imitators like Dunton. The success of both real and false natural philosophy reveals its popularity in the late seventeenth century, a popularity consolidated in the eighteenth. Natural philosophy periodicals circulated freely in the London coffeehouses, with their promiscuous mix of the educated and the ignorant, noble and humble, rich and poor, professional and gentry. Natural philosophy also appeared in the political and social periodicals and booksellers made tidy sums selling volumes on selected aspects of natural philosophy. Royal Society Fellows were the original authors of much of this material, but the market was too big for the virtuosi

to satisfy alone, it created space for hacks and literary figures to write popular natural philosophy. This evidence of enthusiasm runs counter to the ridicule and satire that some literati heaped on the new natural philosophy in drama and verse (see Part IV).

Newton and his work dominated the trade in popular natural philosophy in the early eighteenth century. Between 1680 and 1750 expositions of his ideas came off the presses in huge numbers, while Newton's own writings enjoyed steady sales. From the mid-eighteenth century, interest in Newton declined, while natural history increased. The pioneer natural history writer was the French savant, Count Buffon, a leading naturalist with a writing style that bewitched his readers. In England, followers of Buffon were often laymen like Oliver Goldsmith, the accomplished stylist in poetry, drama and fiction who also wrote a best-selling *History of the Earth, and Animated Nature*. Its significance can be judged from the fact that publishers were prepared to pay £840 for it, comparing well with the sums offered to leading literary fiction writers of the time, such as the £210 offered to Smollett for *Humphrey Clinker* or the £600 to Fielding for *Tom Jones*. By the last quarter of the eighteenth century, natural history books out-sold most other types of serious literature.

Natural philosophy influenced most of the literary figures of the age; even those deeply opposed to it like Swift and Pope. Newtonian mechanical metaphors abounded in early eighteenth-century poetry, while the libraries of the great Whig aristocrats were stuffed with natural philosophy books. By the end of the eighteenth century, the rationale for the foundation of the Royal Society had been met, a public respectful of, and eager to learn about, natural philosophy and the practical applications that supposedly arose from it.

PROFESSIONAL AND POPULAR COMMUNICATION DIVERGE

During the nineteenth century, popular passion for natural philosophy was undermined by its increasing professionalism, symbolized

by the adoption of a new term to describe the activity, 'science'. Many scientists found it easier to communicate only with their peers and there was less need to deal with a wider public, leading to the danger that the public might turn against science. The problem was acute by the mid nineteenth century and several new popular science journals (including *Nature*) were founded to carry on the task of convincing the public that science was an important pursuit. *Nature* has been a long-term success, although most other popular nineteenth-century science journals disappeared. Among professional scientists, writing for popular outlets became the specialized activity of a subgroup with the talent and inclination to undertake it (or the necessity; even by the late nineteenth century there were too few posts in science for those who wanted to make a living from it).

Moves to keep science in the public eye were generally successful in the nineteenth century with ordinary periodicals carrying news about science. Coverage was dominated by biology, the biggest topic being evolution; together with anthropology, archaeology and philosophy. Oceanography, vivisection and spiritualism were also well represented. The voyage of the *Challenger*, examining the science of deep oceans in a circumnavigation of the world, caught the public imagination, much as space travel did 100 years later.

THE EVOLUTION OF THE SCIENTIFIC JOURNAL

While science may have proved popular, the business of professional communication encountered problems. The modern professional pattern of specialized academic journals containing stereotypically structured research articles only matured in the twentieth century. The evolution of this modern publishing institution from the few pioneering proto-journals of the Royal Society and other early learned societies proved long and tortuous.

Despite the ultimate triumph of the short article, throughout much of their history, natural philosophers and scientists made claims for new knowledge by writing monograph books. These had only limited audiences and this problem bedevilled professional

science publication. Early printers and publishers required authors to obtain sponsorship (especially for expensive illustration), or get up a list of subscribers who would pay for the volume in advance, before the printer would set the book. For a subscription list, authors had to collect subscriptions themselves and pay from their own pockets for subscribers who failed to contribute promised money.

Publishing learned scientific journals proved no easier. Scientific and medical journals started as newsletters disseminating matters of interest to the community they served and were not devoted to publishing fresh research. From the late eighteenth century, more specialized journals began to appear, reflecting the fragmentation of science. Many such journals were produced by learned societies, whose lectures and meetings provided a steady stream of material to publish. Even so, journals were often financed and administered by an individual on a freelance basis, a sure recipe for instability. Science journals eventually changed from trade magazines to primary reporting of new research because of increasing pressure of claims for new knowledge from an increasing number of working scientists.

Learned societies were often inefficient at converting meetings into published reports, 5-year delays were not uncommon in the nineteenth century. This stimulated commercial publishers to start journals, which guaranteed faster publication. By late Victorian times, these commercial journals were the majority, although the failure rate of all titles remained high. The lack of big enough commercial markets for scientific research continued to dog learned journal publication into the twentieth century. No ideal system for publishing scientific journals which satisfies all parties has yet been devised.

THE EVOLUTION OF THE SCIENTIFIC PAPER

Since the *Philosophical Transactions of the Royal Society* has been published continuously since the seventeenth century, it has been subject to historical analysis, notably by Atkinson. In the seventeenth and eighteenth centuries most reports to the journal were

letters. The authors presented themselves at the centre of action, referred to themselves in the first person, and freely described their thoughts, feelings and actions. The texts resembled the spoken discourse of everyday life. From the early eighteenth century, a majority of articles began to report original work.

Between 1775 and 1825, texts in the *Philosophical Transactions* underwent a major change. The essay format overtook the letter; authors took a decreasing place in their reports, while the experiments and observations became the core and were described in much greater detail and with more precision. The later stereotyped framework of the science article began to emerge and became the norm later in the nineteenth century. This period also saw a swing to the passive voice, the 'nominal' voice of long strings of noun phrases (a prose style from which the author/scientist is curiously absent), and a rising level of abstraction. By 1900 the passive voice was almost universal.

By the mid nineteenth century, jargon was creeping into *Philosophical Transactions* reports together with tables and mathematical and chemical formulae. By the 1870s, improvements in printing technology allowed more illustrations and some papers were organized round sequences of pictures. Things then remained fairly static until the last quarter of the twentieth century when, in some papers, experimental results and their interpretation began to lose their dominant position and became more focused on extended discussion of theory.

Gross, Harmon and Reidy have made a more comprehensive analysis of texts from an international range of learned scientific journals from the seventeenth century to the present day. They show that, while the emphasis on facts remains dominant, modern scientists are well aware that facts do not speak for themselves. The narrative around the raw data is increasingly cast in the form of an argument; new work derives from the existing canon through extensive citation. We are no longer invited to trust scientists as virtuous members of the gentrified elite, but to accept them as trained

professionals, working at appropriate institutions and publishing in journals whose quality is guaranteed by professional peer review.

The modern scientific paper is a rigidly stereotyped document. There are sections following each other labelled (with minor variations): Introduction, Methods, Results, Discussion and/or Conclusion, References, together with a relatively free-standing Abstract. This standard arrangement implies that science proceeds by induction, gathering data (uncontaminated by pre-conceptions about what these might mean) from which hypotheses or theories (interpretations) are teased out. Presentation of data has been at the core of natural philosophical writing since the seventeenth century from Francis Bacon's principle that knowledge of nature can only be obtained from data about nature, 'The Book of Nature'. But scientific knowledge is an interpretation of that data and it is that interpretation which the author wants readers to accept. Making experimental data (hard, verifiable stuff at least in principle) the central point, together with a quasi-logical framework of interpretation from that data (an inductive progress which moves from specific, concrete events to inclusive generalizations), are designed to persuade readers of the validity of new knowledge claims.

Bacon and Oldenburg both advocated that natural philosophers write as plainly as possible. Language was not to be used as a device to trigger emotion; appeal should be made only to reason and commonsense. Language was to be literal, figurative tropes like metaphors, similes or personifications were not to be used. Modern scientific writing makes every effort to conform to these precepts but the presentational techniques of natural philosophers in the seventeenth and eighteenth centuries showed considerable variations in style. In the late seventeenth century Robert Boyle carried out experiments using an elaborate piece of apparatus (the air pump) producing highly artificial conditions (a vacuum). Shapin and Schaffer argue that Boyle wrote to convince readers of the truth of his observations by describing what had been done in such detail that the reader could imagine that he/she had been there him/herself. His goal in writing