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# Redrawing the Image of Science: Technologies of Illustration and the Audiences for Scientific Periodicals in Britain, 1790–1840

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> In works devoted to [scientific] subjects, representations of physical objects are indispensable; and this cannot be better effected than by wood-cuts, which are now executed with much beauty, and, besides, combine conveniency with cheapness. Science, therefore, as well as literature, lies under deep obligations to the individuals who have carried this art to so high a degree of perfection.
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> *Chambers's Edinburgh Journal* (1836)[1]

> I have witnessed in my own recollection a failure of all the scientific journals almost that have been set on foot … they have all of them failed from an inability to cover their expense, and it is almost an impracticable thing to keep a scientific journal alive in this country.
>
> Richard Taylor (1838)[2]

Over recent years, historians have highlighted the significant role that the transformation in the manufacturing processes, products, and markets for print played in shaping the identity and practice of the sciences in early nineteenth-century Britain. The mechanization of paper manufacture, printing, and binding in the half century between 1790 and 1840 underpinned the emergence of much cheaper scientific publications that were much more widely accessible than previously, enabling the production of educational books, scientific journals, and works of popular science that fundamentally altered the place of science in society and the character of scientific knowledge.[3] However, a crucial aspect of this transformation has been largely neglected by science historians – namely, the fundamental alteration that took place in the technologies of illustration. In the 1790s, publications of quality were almost exclusively illustrated with copper-plate engravings or etchings, while wood cuts were largely reserved for cheaper works, such as school books, and were typically of poor quality. In the 1830s, by contrast, illustration was dominated by wood engravings, some of exquisite quality, alongside a range of competing technologies, including not only copper-plate engravings but also lithographs and engravings on steel. Moreover, wood engravings could be incorporated within the new technologies of mass production, including the steam rotary press and stereotyping. [4]

As historians of journalism have shown, these developments were – alongside the more general changes in printing practice – pivotal in transforming the audiences for printed matter, above all because the cost reductions they offered enabled editors and publishers to use visual matter to appeal to new groups of readers. This was notably the case in the production of new mass-circulation periodicals intended to be attractive to working-class readers, such as the *Penny Magazine* (f. 1832) of the Society for the Diffusion of Useful Knowledge, although it is the *Illustrated London News* (f. 1842) that is often seen as marking the apotheosis of the illustrated journal.[5] As I will explore in this chapter, however, such popular publications were by no means the only periodicals affected by the transformation in illustrative technology. The changes also had important consequences for the burgeoning periodical literature of the sciences and medicine, and, indeed, for scientific and medical books more generally. From the perspective of this volume, the most important of those

consequences relate to the effect that the technological changes had on the economics of scientific publishing. As the epigraphs above make clear, the choice of imaging technology had the potential to radically reduce the cost of scientific illustration in a market where scientific periodicals struggled to cover their costs. As editors, publishers, and societies sought to reach new, larger, or more specialist audiences with scientific periodicals, the changing technologies and economics of illustration formed a key element in their decision-making. Thus, the kinds of communities of scientific practice that could be fostered by the burgeoning periodical press depended in no small measure on these underlying changes in periodical manufacture.

It was not, however, merely the economics of the changing technologies that were of importance for the development of scientific communities. The technological transformations also had significant consequences for the content of scientific communication, offering new graphic possibilities and challenging the expectations of authors, illustrators, and readers. In recent years, historians have shown increasing interest in the visual culture of science in early nineteenth-century Britain. However, while several major studies have taken cognizance of the effects of the changing technologies of illustration, none has placed such technologies in the foreground of the analysis.[6] We still know relatively little about when particular technologies began to become practically available and how quickly they were adopted. There is also much to learn about how those involved – authors and artists, publishers and editors, and readers and observers – viewed the graphic qualities of the different technologies and what the concerns and difficulties were that affected their choice of technology. Important questions remain concerning the effect of their decisions on the processes by which images were produced and the identity of those involved in producing them. Finally, of course, the qualities and conventions of the images produced, and the reactions of those who viewed them, need to be better understood in relation to the technologies employed. Addressing such questions promises significantly to enrich the history of the visual culture of science. In addition, however, it promises to enrich our understanding of how those involved conceived of the audiences for scientific periodicals and other publications, as they considered whether particular kinds of illustration, produced using particular technologies, better served particular readerships.

As the foregoing implies, the technological changes also affected the communities of science in the sense that they affected who was engaged in the scientific work of visual representation. The technicians of print responsible for printed illustrations – significant numbers of women as well as men – have suffered substantial historical neglect. Many cultivators of the sciences were skilled artists, and some were also skilled in the associated printing technologies, but the changes in technology affected the relationships between authors, artists, and print technicians. In the introduction of both wood engraving and lithography, the availability of appropriately skilled draughtsmen and women, engravers, and printers was key. Such individuals often developed close relationships with scientific practitioners, and recovering an understanding of their skills and working practices is highly pertinent to the attempt to understand the development of scientific imagery in the changing technological context of the nineteenth century. The conventions established in the emerging visual languages of the several sciences were conditioned by these practical aspects of image-making, as well as by the economic and political implications of choosing particular technologies.

My object in this chapter is to begin to address some of these fundamental questions about the changes that took place in illustrative technologies in the period between 1790 and

1840, with the intention of shedding light on their consequences for the production of scientific periodicals and for the communities that those periodicals fostered and served. My central claim is that the transformation was a pivotal, and somewhat overlooked, element in the cheapening of scientific periodicals, and in the widening of their appeal in the years before Victoria's accession. At the start of that period, scientific periodicals in Britain were restricted to a handful of learned transactions, illustrated luxuriously with copper-plate figures. By the end, there was a plethora of competing titles, very diverse in price and appearance, and illustrated in a variety of ways. These included society proceedings as well as transactions (now illustrated in increasingly diverse ways) and a range of general scientific journals, such as the *Philosophical Magazine* (f. 1798). They also, however, included cheap technical journals for mechanics, self-proclaimed magazines of popular science, and an increasing range of magazines on natural history and gardening, many of which took advantage of changes in the technologies of illustration – and especially the growth of wood engraving – to offer products that were accessible in form and price to the expanding reading audiences of the industrial age. Such periodicals, which helped to foster wider engagement in the sciences and new communities of science, such as in mechanics institutes and natural history clubs, thus depended on the transformation of illustrative technology alongside the other changes in print manufacture.

The chapter falls into four sections. I begin by considering the strikingly slow take-up of wood-engraving for scientific purposes, and show that, while the new technology seemed to many to offer important advantages, it was ill-suited to the high-price model that dominated scientific publishing in the first quarter of the century. The following two sections examine parallel developments in the 1820s. First, I outline the emergence of lithography in Britain at the end of the 1810s, showing that, in the high-prestige periodicals of learned societies, the new technology began to be used as a means of saving money, while maintaining an air of gentlemanly opulence. Next, I show that it was the new cheap journals of the 1820s – notably the *Mirror of Literature* (f. 1822) and the *Mechanics' Magazine* (f. 1823) – that pushed forward the adoption of wood-engraving as part of a concerted programme of instruction, but with an eye also to entertainment. Similar motives actuated the innovative horticulturalist and journalist John Claudius Loudon in his application of wood-engraving in producing his innovative *Gardener's Magazine* (f. 1826) and *Magazine of Natural History* (f. 1828). In the final section, I briefly examine how the growing adoption of the new technologies in the scientific journals of the 1830s fuelled a debate about how images should operate in relation to the work of science and the character of the communities involved, highlighting some of the questions that remain concerning the grounds on which choices were made concerning the use of illustrative technologies.

While the chapter thus focuses primarily on the importance of illustrative technologies for the history of scientific periodicals, it is also contributes to establishing a wider agenda in the history of the visual and print culture of the sciences in the period. In the course of the chapter, I offer something of an overview of the transformation of illustrative technologies in relation to the sciences generally. To a significant extent, of course, the developments in scientific periodicals paralleled those in scientific books. With research on the subject still in its infancy, this chapter provides a framework on which future researchers might build, and it opens up important new questions about how distinctive the use of the new technologies was in periodicals as opposed to books, and in scientific publications as opposed to other publications. More generally, the chapter identifies some of the key ways in which closer attention to the practicalities, economics, and workers involved in printed illustrations in early nineteenth-century science can reinvigorate the science and visual culture research

agenda by focusing attention on the reasons why certain technologies were preferred to others, and I return to these points briefly at the end.

## The Revival of Wood Engraving and the Persistence of Intaglio Plates, 1790–1820

At the end of the eighteenth century, the standard technology of illustration used in scientific publications depended upon making incisions in a copper plate into which ink was introduced. These were usually made with a sharp implement (engraving) or by using acid to cut away parts of the plate exposed through a 'ground' (etching), although less commonly used variants produced tonal effects (mezzotint and aquatint). These were all highly skilled and labour intensive processes, typically involving a specialist technician. The resultant plates were sometimes known as 'intaglios', from the Italian verb 'intagliare' (to cut in), and all were printed in much the same way. It took the intense pressure of a roller-press to lift the ink out of the incisions and onto the paper, so that intaglio plates had to be printed separately from the letter press, typically on good quality paper. Moreover, the intense pressure meant that the copper – attractive for its relative softness and ease of working – gradually deformed, limiting to a few hundred the number of copies that could be printed before the plate needed repair or replacement. Any colour was usually applied manually, after printing. Thus, while the illustrations produced were often sophisticated and aesthetically rewarding, they were expensive, and added very markedly to the cost of the publication. Not surprisingly, then, such illustrations were typically used sparingly. Yet, as transactions began to be issued by the new learned societies established outside London (notably in Dublin, Edinburgh and Manchester) and by those designed to serve sectional interests (such as the Society of Arts and the Linnean Society), those publications followed the *Philosophical Transactions* of the Royal Society (f. 1665) in including occasional plates. The commercial scientific magazines that began to be issued for the first time in the 1790s, such as the *Journal of Natural Philosophy* (f. 1797) and the *Philosophical Magazine* (f. 1798), similarly included a small number of copper-plate illustrations.

This was the context in which the revival of fine wood engraving began. Wood blocks had been used to produce such important scientific works as Vesalius's *De Humani Corporis Fabrica* (1543), but the technology had shortly afterwards been supplanted for purposes of fine illustration by copper-plate engraving. By the eighteenth century, wood was used chiefly to produce cheap and often crude illustrations, "of little use but to embellish half-penny ballads and school-books for little children."[7] These were chiefly what are sometimes distinguished as "wood cuts", in which the image was produced by cutting into the long grain of a wood block to leave the drawing standing proud in a way that could be printed alongside the letter press.[8] This relief process had many advantages over copper-plate engraving: the block was not only easier to print and cheaper to prepare, but it was also much more durable. However, the quality of the image produced on long-grain blocks was markedly inferior, especially in regard to the fineness of line. Better results could be achieved with wood engraving, where the blocks were cut across the hard end grain of the wood, providing a surface in which finer lines could be produced. While he did not originate it, this was the process that provincial engraver Thomas Bewick took to a new level of sophistication in the last decade of the century, leading contemporaries to consider that a new epoch had opened in the history of wood engraving.[9]

Bewick was first introduced to wood engraving when, as an apprentice in Newcastle-upon-Tyne, he was set to engrave geometrical drawings for local mathematician Charles

Hutton's *Treatise on Mensuration* (1768). However, it was his *General History of Quadrupeds* (1790) that brought the possibilities of wood engraving to public prominence, with the book running through three editions in as many years. Bewick had developed a great love for natural history as a child, and harboured an ambition of offering a work for children with illustrations of animals superior to the woeful copper engravings found in the standard trade work he had encountered in his youth, Thomas Boreman's *A Description of Three Hundred Animals* (1730; 11th ed., 1774). His *History of Quadrupeds* was planned with his former master, Ralph Beilby, who agreed to provide descriptive text, and as the quality of the illustrations became clear, the project became more ambitious.[10] Bewick brought a fineness, delicacy, and artistry to wood engraving – as well as a feel for nature – using an expressive white-line technique in which the picture was produced by cutting out lines and larger areas of white from a black background, rather than merely cutting away ("blocking out") a white background in order to reproduce the black lines of a drawing (see fig. 2.1a). Contemporaries were quick to appreciate the novelty. Wood-block illustrations had been despised since copper engraving became the pinnacle of technique, the *Critical Review* noted, but Vesalius's wood engravings had "a force, a spirit, and an expression" unequalled by Boerhaave's later edition of *De Humani Corporis Fabrica* using copper engravings. The wood engravings in Bewick's work – "executed on a new principle" – also had an uncommon "delicacy and clearness". They were, according to the *General Magazine*, "beyond all comparison – the chef d'oeuvre of the art of wood engraving."[11]

Reviewers considered that the new technique was especially successful – indeed, superior to copper engraving – in picturing animals (see figs. 2.1a and 2.1b). Reviewing Bewick's *History of British Birds* (1797–1804), the *Annual Review* reported that the engraver had

> soon found that the yielding consistence of wood is better fitted to express the ease, freedom, and spirit which ought to characterize portraits of animated beings than the stubborn surface of a metallic substance … There is in [Bewick's engravings] a boldness of design, a correctness of outline, an exactness of attitude, and a discrimination of general character, conveying at the first glance a just and lively idea of each different animal, to which nothing in modern times has ever aspired, and which the most eminent old artists have not surpassed.[12]

Bewick's ability to capture the distinctive character of animals was in part attributed to his special knowledge and love of nature, and his successors were often considered to be inferior in that regard. Yet, informed writers considered that wood engraving offered special opportunities to the artist. An article on "Wood-cuts" for the 1801 supplement to the third edition of the *Encyclopædia Britannica* claimed that, while copper plates were superior "in point of delicacy and minuteness", wood engravings were equally superior "in regard to strength and richness." The blacks and whites produced were unsurpassed, and the technique lent itself to the chiaroscuro effects so much in demand, with strong contrast between light and shade. William Chatto later claimed that this was the "greatest advantage" of wood engraving over copper, in his highly regarded *Treatise on Wood Engraving* (1839). He also noted that by using "lowering" – in which parts of the block were scraped to reduce the height – a softness of texture could also be achieved that was also of value in zoological illustration. Similarly, the *Penny Cyclopaedia* (1833–43) claimed that, while wood engraving could not achieve the "extreme neatness, length and sweep of line, and bold outline of the

copper," it could equal even mezzotint in the "depth of shadow and effect", only with "more distinctness of detail."[13]

The graphic advantages of wood engraving aside, commentators were quick to notice its practical advantages, and its potential in scientific illustration. A pseudonymous writer in the *Monthly Magazine* ("NM") discussed the virtues of the new wood engraving – its "rich fullness of shade, a mellow softness in their gradations, and a great strength of touch" – suggesting that it was excellent for artistic works when on a larger scale. Its chief use, however, would be in reducing costs for illustration on a smaller scale, notably in relation to scientific subjects. Anatomical illustration was likely to be the most important, he continued, observing

> I am perfectly satisfied that anatomical plates can be executed on wood with all the precision possible on copper, and, in some particulars, (especially those where the muscles are represented) with much greater elegance and beauty. A set of such plates, if executed from accurate designs, by having the whole civilized globe for a market, (the explanations being easily printed in different languages) could be afforded at a very low price, so as to bring them within the reach of every student of physic; while the undertaker would be insured in a most abundant profit.

Mathematical diagrams and machinery could also be accurately accomplished using wood engraving; Bewick had demonstrated the technique's value in zoology, and a finer effect might yet be expected in producing illustrations of insects, shells, and minerals. The writer claimed to have been told by a knowledgeable informant that, had the plates of the latest edition of the *Encyclopaedia Britannica* been engraved on wood instead of copper, it would have saved ten guineas per plate in printing costs, or a total of four thousand on the work as a whole.[14] The point was echoed in the encyclopaedia's own 1801 supplement, which asserted that wood engraving was being underused as an "*economical art* for illustrating mechanics and other subjects of science."[15]

Some scientific publications certainly began to be produced using wood engravings. The precedent had obviously been set for works of natural history, and as early as 1807 an abridged edition of Goldsmith's *Animated Nature* was being issued as "illustrated by nearly two hundred Engravings on Wood, in the Manner of Bewick."[16] Nevertheless, the great bulk of publications continued to be illustrated using copper plates, and this applied particularly to the learned transactions and scientific journals. One might seek to account for this in technical terms. For instance, contemporaries had anticipated difficulties with applying the new technology arising from the problem of securing sufficiently large end-grain blocks, and even in 1839, William Chatto estimated five inches square as the maximum block size to be achieved without joining blocks.[17] Yet, while some journal illustrations required a larger canvas than this, many did not, so that it could only amount to a partial explanation. Similarly, we have seen that copper-plate engraving allowed for the production of much finer lines than could be achieved with wood, and it could be time-consuming and expensive to print engraved wood blocks in such a way (using overlays) as to achieve a delicate variation in tone. However, for many purposes this was hardly relevant, and the potential cost savings offered a considerable incentive to use wood engraving where nothing was to be lost.[18] A further consideration is the limited number of wood engravers available to carry out the work, but some reports suggest that, despite their small numbers, wood engravers at this period "did not meet with constant and regular employment."[19] Perhaps more significant was that draughtsmen needed to know how to draw on wood in a way that would get the best out of

the technology, and as late as 1839 Chatto claimed that there was only one active artist adept at drawing for wood engraving.[20]

Underpinning these technical considerations, however, was a more general conservatism that affected the uptake of the new process in general and not least in the scientific periodicals. Wood blocks had hitherto been associated with the production of cheap books, and later commentators also emphasized that wood engraving was "the art of design which is naturally associated with cheap and rapid printing."[21] As we shall see, cheap publishing was indeed the context in which its use first prospered in the 1820s. By contrast, in the high price book market of the first quarter of the nineteenth century, scientific books and journals continued to be expensive, luxury goods. As new specialist societies began to issue transactions alongside those of the Royal Society in the 1800s and 1810s, they took on the form of prestige publications with the associated high production costs. The next section shows that the new technology of lithography offered a way to reduce costs and increase convenience without compromising the sense of luxury.

## Lithography and the Precarious Finances of Prestige Publications, 1820–30

The relatively slow advance of wood engraving in Britain finds something of a parallel in the length of time it took for lithography to gain a foothold. Invented by German actor Alois Senefelder in 1796, the technique was patented by him in London in 1801. However, with many forbidding technicalities to master and with the Napoleonic wars intervening, it was not until the late 1810s that the technology began to be exploited in any systematic way in Britain.[22] As its name implies, lithography involved printing from stone. Instead of the ink being carried in incisions on a metal plate or on the relief surface of a wood block, the process depended on the differential chemical affinities of the ink, such that printing could take place from the flat surface of the fine lithographic limestone. The lithographic artist used waxy crayons or ink to produce the image on the surface of the stone before etching the stone to prepare it to absorb water in the areas not to be printed. The ink consequently adhered only to the image, and could be transferred to paper in a suitable printing press. As a planographic process in which printing took place from a flat surface rather than a raised one, lithography still involved printing the image separately from the book's text, typically on a separate page as a "plate". However, it had many potential advantages over copper plates. The process of preparing the stone was altogether less laborious than that of preparing a plate; moreover, competent draughtsmen could learn to draw on stone altogether more easily than they could learn to engrave or etch, offering a novel immediacy. In consequence, lithography was both more rapid and cheaper than intaglio processes, and additional cost savings resulted from the much greater durability of the lithographic stone, which could yield tens of thousands of impressions without deterioration of quality. In addition, there were a number of graphic advantages. While it could not offer the same clarity as copper engraving, lithography permitted a particularly wide range of marks to be made, and could be used to produce a distinctive pencil-like tone.

It was not, however, until the late 1810s that British commentators began to voice these claims for lithography. Notable among them was the German-born fine art publisher, Rudolf Ackermann, who set himself to promote lithography, establishing a lithographic press in 1816, and offering specimens of what the new technology could achieve in his fashionable monthly, the *Repository of Arts* (f. 1809).[23] He also published Senefelder's *Complete Course of Lithography* in 1819, and several other manuals (both original and in translation) soon

followed. By the early 1820s, London had several active lithographic printers, who could offer a range of variations on the basic technique, including transfer lithography, whereby copper-plate engravings could be printed using lithographic stone. Moreover, lithography's advocates were vocal about its potential value for scientific illustration. As early as 1813, one was suggesting its suitability for the easy production of natural history illustrations at low cost, and this was soon echoed in reports from France, and by Ackermann and his lithographic printer Charles Hullmandel.[24]

Lithography recommended itself to scientific practitioners in a number of ways. The process itself fell within the scientific purview of both geologists and chemists, and William Buckland and Michael Faraday were both involved in offering advice to Hullmandel.[25] Furthermore, it offered the prospect of practitioners being enabled to produce their own drawings for publication without the intervention of a craftsman. While some scientific men, such as the surgeon Charles Bell, had learned to etch copper plates to a high standard, lithography offered the prospect of something much less demanding, with a range of possible benefits. Indeed, the only individual known to have experimented with lithography before the publication of substantial manuals was the sixteen-year-old apprentice geologist, John Phillips. Phillips was probably acting at the instigation of his uncle, William Smith, who was excited by what the technique might offer in relation to publishing his drawings and producing much-needed income. Learning from several brief accounts, including translations from French periodicals in the *Annals of Philosophy* (f. 1813), Phillips was able to set up a short-lived lithographic press in the years 1817–19 and to advertise his services.[26] While Phillips's commercial involvement was unusual, other geologists very rapidly exploited the technique in producing small numbers of copies of their drawings for semi-private circulation.[27] Moreover, they were impressed by the graphic qualities of the prints produced. For instance, a print of an ichthyosaur lithographed for Henry De La Beche in 1819 prompted one observer to claim that the effect was "far better for fossils than the fine engravings to Sir Everard Home's papers in the Philosophical Transactions."[28]

The convenience, cheapness, and graphic qualities of lithography all recommended it for scientific use, but a further recommendation was that the technology most easily produced illustrations as separate "plates". As we have seen, the great bulk of scientific books and journals had been illustrated in this way over the preceding century, while publications in which the illustration and text were combined were typically cheap books, especially for children. In these years before the new industrial technologies were applied to reduce costs, printed matter remained generally very expensive. Scientific publications were chiefly for the wealthy, and many of those with illustrations were notable for their appearance of luxury and prestige. In this context, lithography offered the prospect of producing books more cheaply without altering the form of the publication. Lithographic plates could replace copper plates while exuding the same air of luxury and with none of the "cheap" connotations of wood engravings. Rudolf Ackermann had demonstrated as much in his fashionable *Repository of Arts*, but the point was not lost either on those producing scientific books and journals, and above all the learned transactions.

The circumstance is well illustrated by the case of the Geological Society. When the Society began to produce *Transactions* in 1811 it had strong reasons to desire a prestige publication. To begin with, the society had only just emerged from a battle to establish itself as independent of the Royal Society, not least in the matter of having the right to publish its members' memoirs independently of the *Philosophical Transactions*. Moreover, the society was conscious of the vulnerable status of the nascent science of geology, and the preface to

the first volume highlighted the society's independence from controversial debate relating to theories of the earth. Decisions concerning the production of the *Transactions* consequently rendered the new publication highly reminiscent of the *Philosophical Transactions*. Choosing between specimens of type, paper and form provided for them by society member and printer, William Phillips, they depended on the financial backing of several members to produce a luxurious quarto publication on good paper using ink of the "best quality". To complete the effect, the illustrations, as with the *Philosophical Transactions*, were intaglio engravings, many of them coloured. Whatever else remained to be proved, the geological *Transactions* were properly scientific in form, at least. Moreover, at a price of £1 12s to the book trade and to members – the *Transactions* were not included in the fellows' subscription – their audience was distinctly select.[29]

Having a select audience is one thing, but having a vanishing audience is another, and in 1821, after five volumes of the *Transactions* had been produced, the society's council resolved to "take into its early consideration" the publication's "high price".[30] The print run had been 750 copies, but while all but two hundred copies of the first volume had been distributed by June 1822, almost six hundred of the latest part remained, meaning that more than half of the society's members had not bought a copy (see Figure 4.1). Volumes two to five had been published at the risk of one of its members, the printer William Phillips, costing £4500 to produce, but so far only one had broken even.[31] A sub-committee appointed to enquire into "the most desirable form of publishing," concluded that cost savings could be made by the society publishing the *Transactions* on its own account, by making better use of the costly paper by introducing smaller type and a "fuller page", and by "the substitution, wherever practicable, of Lithographic plates for copper plate engravings."[32] An estimate suggested that lithographed plates would cost just over a third of the price of engraved plates, although by the time many had been coloured, the plates would still cost significantly more than the letterpress printing and the paper combined.[33] The first half-volume under the new regime included just two engravings, compared to twenty-two lithographs, and where the previous half-volume had sold for £2 12s, the new one could be offered at £1 5s to members and booksellers and £1 11s 6d to the public. Sales consequently revived, and within three and a half years, 383 copies had been sold, which yielded a profit of £134.[34]

From the financial point of view, then, the technological change achieved its objective, but it was also successful graphically. Reviewing the new volume of the *Transactions of the Geological Society* in the *Quarterly Review*, Charles Lyell was bullish about the effectiveness of lithography in geological illustration, observing: "This art, so strongly recommended by its superior cheapness, may exert a favourable influence on the future progress of science, and particularly on natural history, which has always been retarded by the unavoidable expense of engraving."[35] Lithography was especially effective in representing the textured surfaces of rock and fossil specimens, as Charles Hullmandel demonstrated with one of the samples in his *Art of Drawing on Stone* (1824). For these purposes, the draughtsman would usually work with lithographic chalk, which produced a distinctive textured quality. Here, the Society was fortunate in being able to draw on the skills of Hullmandel's protégé George Johann Scharf, a draughtsman trained at the home of lithography in Munich, whose skill rapidly became prized by the geologists, for all that they treated him as a 'mechanic' (see figs. 2.2a and 2.2b).[36] Other techniques allowed for more definite lines, such as for use in geological sections, but fine lines were more difficult. Consequently, the Society still resorted to copper plates for some purposes – notably in the production of detailed maps, where fine lines were of the essence. Even here, however, lithography promised assistance. Hullmandel considered that one of the "most useful

applications of lithography" was likely to be the technique by which copper plate impressions could be transferred to stone for printing.[37] Such transfer lithography grew in importance in following years, although it soon had to compete with the use of steel engraving – another new process, which produced intaglio plates that lasted much longer than copper.

It was by no means only the Geological Society to whom the financial and graphic qualities of lithography appealed, but the Society was the first to adopt the technology, and others only gradually followed suit. While the Royal Society and the Society of Arts persisted with copper plates, some other societies began to experiment with the new technology – notably those with animal and plant specimens to illustrate, where the artistry of copper-plate engraving proved especially demanding and expensive. When the short-lived monthly magazine, the *Library of the Fine Arts*, took stock of the state of lithography in England in 1831, it reported not only that Scharf's "accuracy and neatness" had been "highly appreciated" in the *Transactions of the Geological Society*, but that lithography had been shown more generally to have advantages "in the delineation of subjects of natural history." The young flower painter Valentine Bartholomew – who had lived and worked with Hullmandel during the preceding decade, marrying his sister in 1827 – had produced lithographed drawings of flowers that the *Library of the Fine Arts* considered had proved "its fitness for botanical illustrations, and for any subjects to be afterwards finished in colours; as the softness and richness of tint and delicacy of outline in the lithographic drawing render it when coloured hardly distinguishable from an original drawing." The technique had also been "found particularly effective" for "anatomical subjects, and delineations of morbid parts."[38]

Lithography's utility in anatomical illustration had been demonstrated, the writer reported, by the illustrations in the *Medico-Chirurgical Transactions* (f. 1809) of the Medical and Chirurgical Society of London, which had made the transition from copper to stone abruptly between 1825 and 1827. In natural history, the transition was much more tentative. As with the Geological Society, the Linnean Society found the running of its *Transactions* (f. 1791) to be a major drain on its resources, above all because of the cost of the copper plates, many of which were coloured. However, while it began using lithography in 1827, the majority of plates continued to be intaglio.[39] Likewise, while those who founded the society's Zoological Club – soon to become a separate Zoological Society – used transfer lithography to circulate their inaugural resolutions in 1823, the *Zoological Journal* they commenced the following year had the merest brush with the technique, relying almost exclusively on intaglio. It was only in the 1830s, when the Zoological Society began issuing its own *Transactions* (f. 1833), that significant use was made of lithography.[40] Finally, while the Horticultural Society's finances in the 1820s were straightened, and the luxurious qualities of its *Transactions* (f. 1807) added to the financial strain, there was no attempt to cut costs through the application of lithography. Rather, the society experimented much more than others with the use of wood engraving for more mundane illustrations, while also experimenting with some steel intaglio plates.[41]

This conservatism in the natural history transactions deserves further attention, and it is worth noting that lithography was slow to be adopted more generally in the high-prestige, high-cost botanical and zoological part works that were so characteristic of the early decades of the nineteenth century.[42] In particular, the growing number of monthly botanical part works that emulated William Curtis's *Botanical Magazine* (f. 1788) continued the practice of issuing coloured intaglio engravings. Only in 1845, with a new publisher and the lithographic talents of botanical artist Walter Fitch, did the *Botanical Magazine* finally make the change.[43]

In such a well-established, extremely skilled, and high-status culture of illustrative print-making, it is perhaps not surprising that the adoption of lithography was rather slow, despite its attractions in offering plates that were at once relatively conservative in appearance – looking superficially much like intaglio plates – and significantly cheaper to produce.

## Cheap Journals, New Audiences, and the Growth of Wood Engraving, 1820–30

While the learned societies continued to be invested in the expensive form of the prestige publication, albeit with costs now sometimes tempered by the introduction of lithography, the early 1820s witnessed a striking transformation as the first cheap scientific journals employed wood engraving to great effect. The emergence in the 1820s of the first commercially successful cheap periodicals – addressing the rapidly increasing numbers of working- and lower-middle-class readers and using some of the new technologies of mass production – was one of the wonders of the age, contributing to a new sense of the "march of mind". Reflecting that the application of wood engraving "for the general purposes of pictorial illustration was comparatively slow" in the three decades after 1790, William Chatto attributed its rapid growth in the 1820s to radical publisher William Hone – whose political satires and popular miscellanies sold very extensively – and to the Society for the Diffusion of Useful Knowledge (SDUK), an organization founded in 1826 with a view to providing high-quality educational works at cheap prices.[44] However, it was the success of cheap periodical visionary John Limbird (another former radical publisher) that inspired many, including the SDUK, to adopt the extensive use of wood engraving.

During the 1810s, wood engravings had begun to appear occasionally in the broadly based monthly magazines, such as the *Gentleman's Magazine* (f. 1731), that had survived the previous century, and by the start of the 1820s, such magazines were beginning to make more of a regular feature of them. Limbird copied this practice in his *Mirror of Literature, Amusement and Instruction*, an eight-page weekly miscellany, begun in 1822. The magazine was priced at two pence – a price previously only seen in the cheap radical press that had been deliberately suppressed by the imposition of a 4½*d*. newspaper tax in 1819 – and Limbird's strategy of giving readers affordable access to snippets of the literature of the day ensured an unprecedented success, with regular sales probably in the teens of thousands. The inclusion of one or two moderately large wood engravings was a particular selling point that others soon emulated. Indeed, in the wake of Limbird's success, a cascade of cheap, mostly short-lived, weekly publications tumbled onto the market, many of them illustrated, such as the *Nic-Nac* (1822–28), the *Portfolio* (1823–29) and the *Olio* (1828–33). It was above all these new cheap periodicals that popularized wood engraving and served to develop a regular workforce.[45]

The *Mirror*'s weekly melange included a range of scientific and technical illustrations. The first eight numbers, for instance, included illustrations of the tread-mill at Brixton Prison, a "mermaid" specimen that was being exhibited in London, the recent eruption of Mount Vesuvius, and the moose on display at William Bullock's Egyptian Hall in Piccadilly. As this suggests, illustrations often related to spectacles of the day, and their sensationalism was obviously designed to draw the eye and to entertain. Yet, while such illustrations were far from providing the kind of technical information needed for scientific purposes, they were broadly informative, and the journal was clear about its dual mission – to instruct as well as to amuse. Introducing the depiction of the moose, for instance, it observed: "Anxious to keep our promise with the public, in rendering our little work a 'MIRROR of

Literature, Amusement, and Instruction', we shall occasionally give engravings of some of the most remarkable subjects of natural history, accompanied by accurate descriptions."[46]

The advantages of wood engraving for scientific purposes were altogether more clearly on display in one of the *Mirror*'s earliest imitators, the *Mechanic's Magazine*. Founded in 1823 by Limbird's associate, the patent agent Joseph Clinton Robertson, this three-penny weekly had the use of wood engravings at the heart of its mission to inform "the British artisan". Offering a "digested selection" from periodicals and books of the day, it promised

> Accounts of all New Discoveries, Inventions, and Improvements, *with illustrative Drawings*, Explanations of Secret Processes, Economical Receipts, Practical Applications of Mineralogy and Chemistry; Plans and Suggestions for the Abridgment of Labour; Reports of the State of the Arts in this and other Countries; Memoirs, and occasionally Portraits, of eminent Mechanics, &c. &c.

The periodical was true to its word: there were "numerous Wood-cuts" in each number, many of which were diagrams providing information about machinery.[47] This informational aspect was a matter of considerable importance. The *Imperial Magazine* (f. 1819), a general monthly aimed at a lower middle-class dissenting audience, observed that the *Mechanics' Magazine* abounded "with wood engravings, illustrative of the various subjects which required something more than simple description, to render them satisfactorily intelligible to every reader."[48] Not that all the illustrations were purely informational. The first number alone had a portrait of Watt and a depiction of Icarus, both by "the skilful Sears". Yet while Matthew Urlwin Sears was a technically accomplished engraver who worked also for Limbird, one contemporary remembered him as "little of an artist, with no taste," and the *Mechanic's Magazine* certainly offered little to please the aesthete.[49]

The large circulation achieved by the *Mirror of Literature* and the *Mechanic's Magazine* prompted both commercially and ideologically motivated publishers to investigate the possibilities of cheap publishing, and the use of wood engraving expanded rapidly in the process. This was above all the case with the publications of the SDUK. Its flagship "Library of Useful Knowledge", a series of fortnightly six-penny treatises launched in March 1827, was closely modelled on the format of the cheap journals. Moreover, while the "preliminary treatise" on "the objects, advantages, and pleasures of science" was unillustrated, those that followed contained a constant supply of largely diagrammatic illustrations. The society was wary of indulging the sensuality of ill-educated workers, and the preliminary discourse – by Henry Brougham – explained that no figures were to be used in the treatise to "assist the imagination", because the object was to appeal to "reason, without help from the senses." As Anne Secord has shown, this severe judgement "reflected widespread concerns about the nature and management of visual pleasure."[50] Yet, the informational content of illustrations was highly prized. Indeed, by 1837 the editor of the *Penny Mechanic* (f. 1836) could quote as familiar the maxim that "one square inch of wood is worth a page of letter press," pointing out that illustration had enabled him to explain "many complicated pieces of machinery … that could not have been described without the assistance of the draughtsman."[51]

Very rapidly, moreover, the SDUK widened its perspective on the role of illustration, as it expanded its commitment to the role of pleasure in learning. Reflecting that much of the

reading that was done for "mere amusement" might be "made a source of great improvement," the society's first annual report announced its intention to commence a "Library of Entertaining Knowledge" combining "instruction and amusement, comprising much entertaining matter as can be given along with useful knowledge, and as much knowledge as can be conveyed in an amusing form."[52] These volumes – which came to be published by cheap publishing visionary Charles Knight – greatly expanded the society's illustrative ambition and technical prowess in the use of wood engraving. Knight's own early volume, *The Menageries: Quadrupeds Designed and Drawn from Living Subjects* (1829), provides a good example. Here, the depiction of animals within a range of scenes – executed by "rising young men", two of whom were later Royal Academicians – was clearly intended to be quite as pleasurable as instructive.[53] In the years that followed, Knight became the SDUK's sole publisher, and it was his passion for the improving qualities of artistic representation that led to the dominant position of high-quality wood engravings in the *Penny Magazine*, commenced in March 1832.[54] Moreover, the achievement depended on technical experimentation in the preparation of the wood blocks – especially in relation to lowering – that enabled them to be printed using the steam presses of London printer William Clowes in order to deliver the magazine's print runs of up to 200,000 copies. Since the 1820s Clowes had been a keen advocate of the new steam technology as a means of cheapening and expanding the market for print, and Knight worked closely with him in achieving a high quality product.[55]

The degree of success enjoyed by the new cheap journals of the 1820s in the use of wood engraving stands in stark contrast to the continuing conservatism not only of the learned transactions, but also of the established scientific and technical journals, and of such new titles as David Brewster's *Edinburgh Journal of Science* (f. 1824) and Thomas Gill's *Technical Repository* (f. 1822). However, two commercial journals of the late 1820s offered a striking demonstration of the utility of wood engraving for more learned scientific purposes – the *Gardener's Magazine* (1826–43) and the *Magazine of Natural History* (1829–40). Both were the productions of Scottish landscape gardener and author, John Claudius Loudon, working with leading London publishers Longmans.

Loudon was a farmer's son who had been apprenticed as a nurseryman and studied at the University of Edinburgh. On moving to London he had soon established a reputation in horticultural circles, becoming a fellow of the Society of Arts, the Horticultural Society, and the Linnean Society. With support from Sir Joseph Banks, he published a monumental 1500-page *Encyclopaedia of Gardening* with Longmans in 1822. The work was novel in its comprehensive scope, and was soon being described as a "standard book", passing through multiple editions. Moreover, while at £2 10s. it was very expensive, it was intended for use by "Practical Gardeners" as well as their patrons, embodying Loudon's Benthamite vision for their professional education.[56] With such a readership in view, Loudon illustrated the work with nearly six hundred wood engravings by one of the capital's leading wood engravers, Robert Branston, which reviewers considered did the artist "the highest credit."[57] The *Gardener's Magazine*, launched in January 1826, offered a periodical continuation of this encyclopaedia, providing an account of improvements in gardening that was "accessible to the practical gardener, land-steward, bailiff, and others concerned in country affairs." The work was not cheap, but at 3s. 6d. per quarter it worked out roughly the same as a regular subscription to the *Mechanic's Magazine*, albeit for just over half the number pages. Once again, it was to be illustrated by wood engravings "where useful", and the first four quarterly issues contained a hundred illustrations between them, which ranged from diagrams of plant

dissections and tools, through views of horticultural structures to pictorial landscapes and portraits (see figs. 2.3a and 2.3b).[58]

The wood cuts were a crucial part of the innovative package that Loudon sought to offer, since they helped to keep costs low, and thus permitted a greater range of illustration. Here, his eye was clearly on the dream of a wider audience embodied in the new cheap journals, rather than on investing in lithography to emulate the learned transactions. The editor spelled out his vision more explicitly at the start of the following year, having been piqued by a pointed reference in the preface to the *Transactions of the Horticultural Society* (f. 1807) to the practice of some journals of reprinting original matter from that publication. In response, Loudon wanted to emphasize, first, that the original matter in his own magazine was quite equal to that in the *Transactions* ("the same persons, and sorts of persons, write in both works"), secondly, that his magazine worked out at around one-sixth of the price of the *Transactions*, and, thirdly, that while its articles were "not ornamented by coloured plates, or engravings from copper or steel", yet they were "illustrated by a greater number of engravings from wood, sufficiently intelligible for all useful purposes, than is the present or any former volume of the Horticultural Transactions." Indeed, Loudon claimed, when the magazine drew on the *Transactions*, it not only offered a usefully abridged account, but it "frequently illustrated this essence by engravings, which rendered it of more value than the original in its unabridged and unillustrated state" – in the case of a recent number, eleven engravings "were 'composed expressly for the purpose." Above all, he considered that his added wood engravings provided additional and valuable information, as when he included detailed diagrams to make clearer how the original author suggested grafting rose buds.[59]

Contemporaries agreed that the magazine would mark a "new era" in the gardening literature: it was "of incalculable value to working gardeners and farmers," who could not afford to buy "expensive works, such as the Horticultural Transactions, Linnæan Transactions, and other works containing much valuable matter, but not accessible to general readers."[60] Moreover, while the learned societies' transactions proved a drain on their resources, the low cost of engravings and other cost-cutting measures of the *Gardener's Magazine* meant that profits were considerable, with Loudon earning around £500–750 annually in the early days.[61] In such circumstances, and with a new *Encyclopaedia of Plants* in preparation, it is not surprising that Loudon now decided to apply the format for a related audience in his 3s. 6d. bi-monthly *Magazine of Natural History*, which he alternated with the now bi-monthly *Gardener's Magazine*. The new magazine emulated the existing one in its emphasis on providing ready access to the progress of science, while seeking to "extend a taste for this description of knowledge among general readers and observers, and especially among gardeners, farmers, and young persons resident in the country." Moreover, initial sales of more than two thousand copies suggest that Loudon was reaching a wide audience.[62]

Once again, the use of wood engravings – there were over two hundred in the first volume – was a key aspect of the magazine's cost-saving formula. On this occasion, however, it was not only the name of the engraver that appeared in the publicity materials. Robert Branston's artistry was admired, but natural subjects were not his forte. However, the London school of wood-engravers of whom he was considered the head were used to working from others' designs. Loudon arranged to have the botanical drawings carried out by well-respected naturalist and botanical artist, James de Carle Sowerby, the zoological ones by William Harvey (by this time London's premier wood-block draughtsman), and the trees by landscape painter and tree specialist Jacob George Strutt.[63] With such high profile artists involved, he could hope to convince knowledgeable naturalists that for many purposes his

magazine was capable of relaying information graphically that was not inferior to what might be expected in the competing *Zoological Journal* (f. 1824), with its copper plates. Indeed, he challenged his readers to compare his wood engraving of Geoffroy's Shrike, *Lanius plumatus*, with the copper plate in Edward Griffith's revised edition of Cuvier's *Animal Kingdom* (1827–35) on which it was based (figs. 2.4a and 2.4b). It was, he considered "nearly as expressive, or, at least, sufficiently so for every useful purpose." Moreover, he argued that wood engraving could be used to add additional diagrams offering the osteological information so central to Cuvier's system. Instead of making their work ludicrously expensive with intaglio plates, Griffiths and his publishers should have used wood, Loudon argued.[64] Certainly, Loudon's use of wood engravings in his new magazine helped to keep its finances reasonably manageable, even though sales soon declined. Moreover, as we shall see shortly, it established a model for many competitors. However, the growing prominence of wood engraving in the context of the scientific journal only further fed the debate concerning the relative merits of different kinds of illustrative technology for scientific purposes, and it is to this that we now briefly turn.

## Illustrative Technologies, the Politics of Knowledge, and the Purpose of Scientific Imagery, 1830–40

By 1830, then, several scientific periodicals had adopted the new illustrative technologies of lithography and wood engraving in preference to intaglio, demonstrating their potential utility for a range of scientific purposes. In both cases, the decision reflected the financial advantages that the new technologies offered. In prestige periodicals, such as the transactions of learned societies, use of lithography could make the difference between financial disaster and triumph. In the new cheaper periodicals of the "useful knowledge" movement of the 1820s, wood engraving offered a means of securing all the attractions of illustration within a tight budget, and consistently with other new technologies of the industrial age, such as stereotyping and the steam press. Yet, while lithography maintained a gentlemanly feel in the luxuriant plates of learned transactions, wood-engraving and the cheap periodicals in which it was used spoke directly to the changing politics of knowledge. The technology of illustration became inextricably linked to the audiences for science and the purposes to which illustrations were put. In 1839, William Chatto observed:

> Wood-engravings are not to be estimated by a comparison with copper-plates; but are to be judged of by the power and significance with which they excite ideas in the mind, with reference to the means employed in their execution, and on a consideration of the thousands whose knowledge is thus extended, and whose pleasure is thus increased, compared with the hundreds who can afford to purchase copper-plate engravings.[65]

In such a climate, the continued employment of more expensive illustrative technologies was a statement about the legitimate users and proper uses of the knowledge texts they adorned.

As Anne Secord has shown, many in this changing world considered the sensory pleasures offered by illustrations to be a key means of recruiting potential practitioners into the enterprise of natural history. The great flowering of illustrated horticultural and natural history periodicals that occurred in the 1830s – Ray Desmond reports that fifteen such periodicals were established in 1830s – doubtless contributed to building the large and active community of natural history enthusiasts so characteristic of Victorian Britain.[66] Some, such

as the shilling monthly *Horticultural Register* (1831–36) of the Duke of Devonshire's landscape gardener Joseph Paxton, copied Loudon's formula closely, including the use of wood engravings. Many others, however, continued to use other illustrative technologies – including both intaglio (where the more resilient steel was increasingly used to reduce costs) and lithography – despite their higher cost and the precarious finances that led most magazines to fail. Indeed, within a year Paxton's *Horticultural Register* was also including intaglio plates, and when Paxton commenced his two-shilling monthly *Magazine of Botany* in 1833, that included hand-coloured lithographs alongside the wood engravings in the text. Even the bargain basement six-penny monthly *Floricultural Cabinet* (1833–59) of Paxton's erstwhile collaborator, Joseph Harrison, shifted from wood engravings to intaglio for its coloured botanical plates after five issues.[67] James Rennie's *Field Naturalist* (1833–35) and Richard Owen's *Zoological Magazine* (1833) also combined wood engraving with plates. Most strikingly, the *Magazine of Zoology and Botany*, begun by leading Edinburgh naturalists in 1836, was dominated by its coloured plates (three per bimonthly number) rather than its wood engravings. This was the magazine – remodelled by savvy journal printer Richard Taylor as the *Annals of Natural History* (1838–) – that survived the attritional early years of natural history journal publishing, despite the fact that its illustrations cost twice those of the *Magazine of Natural History*.[68]

Such choices in illustrative technology clearly reflected perceptions concerning the aesthetic desires of potential purchasers, and, in a related manner, evolving conventions of format. However, choices were also sometimes shaped by judgements concerning the adequacy of wood engraving for the purposes of scientific instruction and communication. In 1835, William MacGillivray – the conservator of the museum of the Royal College of Surgeons in Edinburgh and collaborator with Audubon – began a two-penny fortnightly *Edinburgh Journal of Natural History, and of the Physical Sciences* (f. 1835), which contained some wood engravings but also a colour plate. MacGillivray explained:

> Within the last few years, various cheap publications on this subject, illustrated by engravings on wood, have led all classes to observe and to enjoy the ever-varied beauties of the creation. But no description, however correct, or no wood-cut, however well executed, can give that complete idea of a natural object, which is effected by an engraving on steel, when coloured with accuracy. The enormous price at which these illustrations of a higher order are usually sold, has alone prevented them from becoming extensively popular. Hitherto, coloured engravings, executed with beauty and correctness, have been accessible to the wealthier classes alone. It is proposed, in this work, to place elegant engravings of the choicest productions of Nature, within the reach of all classes of the community[69]

To MacGillivray, the desire to expand the social range of those engaged in natural history by using cheaper illustrative technologies risked undermining informational accuracy. Yet, while the use of colour certainly conveyed additional information, it is otherwise far from clear where the supposed superiority of intaglio lay (see figs. 2.5a and 2.5b).

Indeed, practitioners were not agreed as to the most informative illustrative technology for the purposes of natural history. The aesthetic qualities associated with the hand-coloured intaglio plates that sold botanical part-works – including such periodicals as the *Botanical Magazine* (f. 1787) – were considered by some to be fraught with dangers which the new, cheaper technologies might actually obviate. In 1831 cryptogamic botanist

William Wilson wrote to his friend, Glasgow's professor of botany William Jackson Hooker, about the need for "a well conducted work of botanical illustrations, either in Lithograph or Woodcut." He continued:

> if I could draw with facility, I would myself attempt it – accurate dissections, & essential characters of genera & species would I am convinced do more towards the propagation of the science, than all the coloured figures that ever were or will be published: these often do harm instead of good & are more likely to make "knowers of species" than sound botanists.... Figures with dissections have a very high value; superior even to a dried specimen, if faithfully executed; but then they are so expensively got up that very few can afford to purchase them, compared with the number who would buy woodcuts or Lithographs, such as might be depended upon – [70]

As Anne Secord has shown, Hooker and other botanists shared Wilson's concerns about the constraints that a desire to satisfy artistically motivated book purchasers placed on botanical illustration. Hooker was a talented botanical artist, who in 1827 had become the editor and sole draughtsman of the *Botanical Magazine*, with its hand-coloured intaglio plates. Yet most of the copies of his *Botanical Miscellany* (f. 1830) were sold with uncoloured plates, albeit that it was not until 1840 (in the successor *Journal of Botany*, f. 1834) that these were lithographed rather than engraved.[71] Joseph Paxton likewise sometimes considered that readers might learn more from the wood engravings in his *Magazine of Botany* than from the elaborate colour plates.[72]

The complexity of decision-making in relation to illustration might be especially evident in natural history periodicals, but other scientific periodicals had similar issues to contend with as they negotiated the new technologies. Some of the new scientific and technological magazines that appeared in the 1830s, such as the *Railway Magazine* (1835–77) and the *Civil Engineer* (1837–68), adopted wood engravings. Others, such as the *Annals of Electricity, Magnetism, and Chemistry* (1836–43), maintained the established practice of using separate plates, but substituted lithography for copper. Only gradually over the next two decades did wood engravings become the standard illustrations in the more arcane scientific periodicals, and in the new "proceedings" that scientific societies began to produce in replacement of their transactions. In all of this, decisions involved balancing considerations relating to producing a product that was appropriately priced to develop the desired community of readers, while offering printed images that were considered informationally and aesthetically suitable for their purposes.

## Conclusion

Parallel to the mechanization of book production that took place in the early decades of the nineteenth century, the transformation of illustrative technologies had profound consequences for the sciences. The rise of wood engraving and lithography in particular radically altered the possibilities for scientific illustration. Most obviously, the new techniques opened up a new graphic repertoire. The vividness of wood engravings and the tactile qualities of lithographs extended the palette of scientific artists, offering new effects that were of value for particular purposes. Arguably more radical, however, was the effect that the new technologies had on the economics of scientific illustration. While much remains to be done to understand the financial implications, the new techniques were clearly

significantly cheaper than the intaglio technologies that had long dominated scientific illustration, and given the high relative cost of illustration in the overall budget of publication, such savings had the potential to produce an economic transformation. Nowhere was this more evident than in relation to periodicals. Within the learned societies, lithography and, to a lesser extent, wood engraving, played a significant role in reducing spiralling costs. At the same time, wood engraving began to be used to offer scientific illustrations within the new cheaper commercial periodicals, often with a twin emphasis on instruction and amusement. Such illustrations formed a key element in the establishment of diverse kinds of scientific periodicals, most notably the types of gardening and natural history magazines developed by John Loudon. For Loudon, the use of wood engraved illustrations was a core part of his mission to expand the communities of informed and actively engaged gardeners and naturalists.

As other chapters in this book show, the role of periodicals in expanding communities of scientific practitioners was often controversial, but the role of illustrations within that was likewise a matter of dispute. The provision of cheaper illustrations in order to engage and inform new periodical readers might have any number of deleterious consequences. As Anne Secord has shown, the use of imagery in teaching readers about nature was inherently suspect in an age when the pleasure it generated might as easily degenerate into sensuality as engender rationality.[73] More than that, there is evidence to suggest that the graphic qualities of the new, cheaper technologies – especially wood engraving – were considered by some to be prone to mislead. However, while this chapter has begun to uncover some of the considerations that came into play in choosing between the growing range of available technologies, much remains to be done. It was certainly far from being the case that the older and more expensive intaglio technologies, often combined with hand colouring, were graphically to be preferred for scientific purposes. On the contrary, it seems that they were sometimes preferred because of a sense of their beauty or their social exclusivity, to the detriment of their scientific utility. In this regard, the account in this chapter raises as many questions as it answers, but in so doing, it opens up a rich vein for further research in the history of nineteenth-century scientific illustration. Moreover, it is a history that extends far beyond the period explored here, since the rapid rate of change in illustrative technology in the first part of the century if anything only accelerated in the decades that followed.

**List of Illustrations**

Fig. 2.1. The comparative value of wood-engraving in conveying a 'just and lively idea' of animals. Illustrations of the squirrel from (a) Thomas Bewick's *General History of Quadrupeds* (Newcaste-upon-Tyne: S. Hodgson, R. Beilby, and T. Bewick; London: G. G. J. Robinson and C. Dilly, 1790), p. 333 (wood engraving by Thomas Bewick) and (b) Oliver Goldsmith's *History of the Earth, and Animated Nature* (8 vols, London: F. Wingrave, 1791), vol. 4, opposite p. 23 (copper-plate engraving by Isaac Taylor), showing the superiority of the former in this regard. Reproduced with the permission of Special Collections, Leeds University Library.

Fig. 2.2. The comparative value of lithography in providing a powerful sense of the texture of specimens. Two illustrations in the *Transactions of the Geological Society*, both based on Gideon Mantell's drawings of the plesiosaurus: (a) new series, volume 1 (1824), plate 21, produced using lithography (by George Scharf) and (b) original series, volume 5 (1817), plate 42, produced using copper engraving. Images from the Biodiversity Heritage Library (www.biodiversitylibrary.org), contributed by (a) California Academy of Sciences Library and (b) Harvard University, Museum of Comparative Zoology, Ernst Mayr Library.

Fig. 2.3. The comparative value of wood engraving for practical purposes. Two illustrations of *Passiflora* species: (a) a wood engraving from the *Gardener's Magazine*, volume 1 (1826), p. 16, to illustrate the 'fleshy rays' that the author ('an Amateur') advised should be removed to avoid causing putrefaction in the fruit, and (b) a hand-coloured copper engraving from the *Transactions of the Horticultural Society*, volume 3 (1820), plate 3, to illustrate the appearance of the leaves, flowers, and fruit of a particular cultivar for taxonomic purposes. Images from the Biodiversity Heritage Library (www.biodiversitylibrary.org), contributed by (a) Smithsonian Libraries and (b) Missouri Botanical Garden, Peter H. Raven Library.

Fig. 2.4. The comparative value of wood engraving for scientific purposes. Two illustrations of Geoffroy's Shrike, *Lanius plumatus*, compared by John Claudius Loudon: (a) a wood engraving from the *Magazine of Natural History*, volume 1 (1829), p. 276 and (b) a copper engraving from Edward Griffith's *The Animal Kingdom, Arranged in Conformity with its Organization, by the Baron Cuvier*, 16 vols (London : Geo. B. Whittaker 1827–35), 6: opp. p. 484. Images from the Biodiversity Heritage Library (www.biodiversitylibrary.org), contributed by (a) Natural History Museum Library, London and (b) University Library, University of Illinois Urbana Champaign.

Fig. 2.5. Wood engraving and hand-coloured steel engraving juxtaposed. Illustrations from number 15 (August 1836) of the *Edinburgh Journal of Natural History*, depicting (a) specimens of marine gastropod and fossil elk using wood engraving and (b) specimens of owl using steel engraving. Images from the Biodiversity Heritage Library

(www.biodiversitylibrary.org), contributed by Harvard University, Museum of Comparative Zoology, Ernst Mayr Library

**References**

[1] "Biographic Sketches: Thomas Bewick", *Chambers' Edinburgh Journal*, 2 January 1836, 388–89, on p. 388

[2] *First Report from the Select Committee on Postage; Together with the Minutes of Evidence, and Appendix*, House of Commons Parliamentary Papers, Session 1837–38, 33: 1–516, on p. 319.

[3] See, for example, Jonathan R. Topham, 'Scientific Publishing and the Reading of Science in Nineteenth-Century Britain: A Historiographical Survey and Guide to Sources', *Studies in History and Philosophy of Science* 31 (2000), 559–612; James A. Secord, *Victorian Sensation: The Extraordinary Publication, Reception and Secret Authorship of "Vestiges of the Natural History of Creation"* (Chicago: University of Chicago Press, 2000), esp. ch. 2; and Aileen Fyfe, *Science and Salvation: Evangelicals and Popular Science Publishing in Victorian Britain* (Chicago: University of Chicago Press, 2004).

[4] See Michael Twyman, "The Illustration Revolution", in *Cambridge History of the Book in Britain*, vol. 6, *1830–1914*, ed. David McKitterick (Cambridge: Cambridge University Press, 2009), 117–43; Paul Goldman, "The History of Illustration and Its Technologies", in *The Book: A Global History*, ed. Michael F. Suarez and H. R. Woudhuysen (Oxford: Oxford University Press, 2013), 231–44; and Bamber Gascoigne, *How to Identify Prints: A Complete Guide to Manual and Mechanical Processes from Woodcut to Jet Ink* (London: Thames and Hudson, 1986).

[5] See, for example, Patricia Anderson, *The Printed Image and the Transformation of Popular Culture, 1790–1860* (Oxford: Clarendon Press, 1991) and Celina Fox, *Graphic Journalism in England During the 1830s and 1840s* (New York & London: Garland, 1988).

[6] See, for example, Martin Rudwick, "The Emergence of a Visual Language for Geological Science 1760–1840",1840', *History of Science*, 14 (1976): 149–95, Lorraine J. Daston and Peter Galison, *Objectivity* (New York, Zone Books, 2007); and Anne Secord, "Botany on a Plate: Pleasure and the Power of Pictures in Promoting Early Nineteenth-Century Scientific Knowledge", *Isis* 93 (2002): 28–57.

[7] Anon, "[Review of *History of British Birds*, by Thomas Bewick]", *Annual Review*, 3 (1804): 729–37, on p. 729.

[8] The distinction between "wood cut" and "wood engraving" was not used consistently in the period, and usage can often prove confusing to the historian.

[9] See James Mosley, "The Technologies of Printing" and Tim Clayton "Book Illustration and the World of Prints" in *Cambridge History of the Book in Britain*, vol. 5, *1695–1830*, ed. Michael F. Suarez and Michael L. Turner (Cambridge: Cambridge University Press, 2009), 163–99, on pp. 182–84, and 230–4, on p. 240).

[10] On Bewick see *DNB* and Jenny Uglow, *Nature's Engraver: A Life of Thomas Bewick* (London: Faber and Faber, 2006), esp. chch. 13–14.

[11] Anon, "[Review of *General History of Quadrupeds*, by Thomas Bewick]", *Critical Review* 70 (1790): 414–18, on p. 414–15; Anon, "[Review of *General History of Quadrupeds*, by Thomas Bewick]", *General Magazine* 4 (1790): 540–41, on p. 541.

[12] Anon, "[Review of *History of British Birds*, by Thomas Bewick]", *Annual Review*, 3 (1804): 729–37, on p. 729.

[13] Anon, "Wood-cuts", in *Supplement to the Third Edition of the Encyclopædia Britannica; or, A Dictionary of Arts, Sciences, and Miscellaneous Literature*, ed. by George Gleig (Edinburgh: Thomas Bonar, 1801, 2 vols), 2: 809–12, on p. 811; [W. A. Chatto], *A Treatise on Wood Engraving* (London: Charles Knight & Co., 1839), esp. pp. 568–69,

683, and 710; and "Wood-Engraving" in *Penny Cyclopaedia*, ed. by George Long (London: Charles Knight, 1833–43, 27 vols), 27: 522–26, on p. 526.

[14] N. M., "Remarks on Engraving on Wood", *Monthly Magazine*, 5 (1798): 111–12, on p. 112; the letter was reproduced in the *Edinburgh Magazine*.

[15] Anon, "Wood-cuts", in *Supplement to the Third Edition of the Encyclopædia Britannica; or, A Dictionary of Arts, Sciences, and Miscellaneous Literature*, ed. by George Gleig (Edinburgh: Thomas Bonar, 1801, 2 vols), 2: 809–12, on pp. 811–12.

[16] *An Abridgement of Dr. Goldsmith's Natural History of Beasts and Birds. Interspersed with a Variety of Interesting Anecdotes, and Illustrated by Nearly Two Hundred Engravings on Wood, in the Manner of Bewick* (London: Scatcherd and Letterman; and Langley and Belch, 1807).

[17] N. M., "Remarks", 111; Chatto, *Treatise on Wood Engraving*, 640. See also Twyman, "The Illustration Revolution", 122.

[18] Twyman, "The Illustration Revolution", 124–25; "The Commercial History of a Penny Magazine", *Penny Magazine*, 2 (1833): 377–84, 417–24, 465–72, 505–11, on p. 420; John Buchanan-Brown, *Early Victorian Illustrated Books: Britain, France and Germany, 1820–1860* (London: The British Library, 2005), 21.

[19] William Andrew Chatto, "Wood-Engraving: Its History and Practice", *Illustrated London News*, 4 (1844): 251–54, 257–59, 273–74, 293–94, 309–10, 325–26, 357–58, 405, 417, 425, on p. 405.

[20] Chatto, *Treatise on Wood Engraving*, 692–93.

[21] "Commercial History of a Penny Magazine", 420.

[22] Michael Twyman, *Lithography, 1800–1850: The Techniques of Drawing on Stone in England and France and Their Application in Works of Topography* (London: Oxford University Press, 1970), esp. ch. 3; C. Hullmandel, *The Art of Drawing on Stone, Giving a Full Explanation of the Various Styles, of the Different Methods to be Employed to Ensure Success, and of the Modes of Correcting, as Well as of the Several Causes of Failure* (London: C. Hullmandel & R. Ackermann, [1824]).

[23] John Ford, *Ackermann, 1783–1983: The Business of Art* (London: Ackermann, 1983), 61–64; Anon, "Some Account of the Art of Lithography, or Process for Taking Fac-Simile Impressions of Drawings from Stone", *Repository of Arts* 2d ser. 3 (1817): 222–25, 284–86, and 343–44; 4 (1817): 33–34.

[24] Michael Twyman, ed., *Henry Bankes's Treatise on Lithography* (London: Printing Historical Society, 1976 [1813]), 10; *Monthly Magazine* 44 (1817): 355; Anon, "Some Account", 285; Hullmandel, *The Art of Drawing on Stone*, xv.

[25] Hullmandel, *The Art of Drawing on Stone*, 1n.; Michael Twyman, ed., *John Phillips's Lithographic Notebook, Reproduced in a Facsimile from the Original at Oxford University Museum of Natural History* (London: Printing Historical Society, 2016), 16, 19–20; James Hamilton, "Artists, Scientists, and Events", in *Fields of Influence: Conjunctions of Artists and Scientists, 1815–1860*, ed. James Hamilton (Birmingham: University of Birmingham Press, 2001), 1–30, on pp. 11–12.

[26] Twyman, *Phillips's Lithographic Notebook*; Jack Morrell, *John Phillips and the Business of Victorian Science* (Aldershot: Ashgate, 2005), 25–27.

[27] John C. Thackray, "Separately-Published Prints of Fossils in Nineteenth-Century Britain", *Archives of Natural History* 12 (1985): 175–99.

[28] Quoted in Thackray, "Separately-Published Prints", 182.

[29] Gordon L. Herries Davies, *Whatever is Under the Earth: The Geological Society of London, 1807 to 2007* (London: Geological Society, 2007), 36–39, on p. 37; Council Minutes, 15 February 1811, Geological Society of London, GSL/CM1/1/21.
[30] Council Minutes, 21 December 1821, GSL/CM1/1/213.
[31] Council Minutes, 19 June 1822, GSL/CM1/1/237.
[32] Council Minutes, 15 February and 21 June 1822, GSL/CM1/1/222 and 242.
[33] Council Minutes, 8 March 1822, GSL/CM1/1/224.
[34] Council Minutes, 21 June 1822, GSL/CM1/1/243; 2 February 1826, GSL/CM1/2/ 70.
[35] [Charles Lyell], "[Review of *Transactions of the Geological Society*]", *Quarterly Review* 34 (1826): 507–40, on p. 525.
[36] Hullmandel, *The Art of Drawing on Stone*, 52 and pl. 6. On Hullmandel, see *DNB*; on Scharf as a 'mechanic' see Caroline Arscott, "George Scharf and the Archaeology of the Modern", in *George Scharf: From the Regency Street to the Modern Metropolis* (London: John Soane Museum, 2009), 26–41, on p. 41.
[37] Hullmandel, *The Art of Drawing on Stone,* 79.
[38] Anon, "A View of the Present State of Lithography in England", *Library of the Fine Arts*, 1 (1831): 201–16, on pp. 211–12.
[39] The high proportion of society expenditure devoted to the *Transactions* is detailed in the annual accounts in the council minutes. See especially the review of expenditure in Council Minutes 2 (1826–43), Linnean Society, pp. 304–20. See also Andrew Thomas Gage and William Thomas Stearn, *A Bicentenary History of the Linnean Society of London* (London: Academic Press, for the Linnean Society of London, 1988), esp. ch. 20.
[40] On the lithographed resolutions (24 March 1823), see the Correspondence Relating to Formation of the Zoological Club, Linnean Society, MSS MISC SP621–34, f. 21.
[41] Harold R. Fletcher, *The Story of the Royal Horticultural Society, 1804–1968* (London: Oxford University Press, 1969), 114, 122, and 158.
[42] A few exceptions are noted in Wilfred Blunt and William T. Stearn, *The Art of Botanical Illustration,* New Ed. (Woodbridge, Suffolk: Antique Collectors' Club in association with the Royal Botanic Gardens, Kew 1994), 252. Other notable examples of the use of lithography in natural history in the 1830s include John Gould's *Century of Birds Hitherto Unfigured from the Himalaya Mountains* (1830–32) and Charles Darwin's *Zoology of the Voyage of H.M.S. Beagle* (1839–43).
[43] Jan Lewis, *Walter Hood Fitch: A Celebration* (London: HMSO, 1992), 10.
[44] Chatto, "Wood Engraving", p. 405.
[45] Jonathan R. Topham, "John Limbird, Thomas Byerley, and the Production of Cheap Periodicals in Regency Britain", Book History 8 (2005): 75-106.
[46] *Mirror of Literature*, 1 (1822–23): 113; Jonathan R. Topham, "The *Mirror of Literature, Amusement and Instruction* and Cheap Miscellanies in Early Nineteenth-Century Britain", in *Reading the Magazine of Nature: Science in the Nineteenth-Century Periodical*, ed. by Geoffrey Cantor et al. (Cambridge: Cambridge University Press, 2004), 37-66, on pp. 52–62.
[47] *Mechanic's Magazine*, 1 (1823–24): 16 (emphasis added).
[48] Anon "[Review of *Mechanics' Magazine*]", *Imperial Magazine*, 10 (1828): 562–63, on p. 563.
[49] *Mechanic's Magazine*, 1 (1823–24): 1, 8, 11; W. J. Linton, *The Masters of Wood Engraving* (New Haven and London: Author, 1889), 201.

[50] [Henry Peter Brougham], *The Objects, Advantages and Pleasures of Science* (London: Baldwin, Cradock, and Joy, 1827), 6; Secord, "Botany on a Plate", 30–31.

[51] Anon, "Preface", *Penny Mechanic* 1 (1837): iii–iv, on p. iv. The source of the maxim is unknown.

[52] Quoted in [Charles Knight], "Education of the People", *London Magazine,* 3d ser. 1 (1828): 1–13, on p. 8.

[53] Charles Knight, *Passages of a Working Life during Half a Century, With a Prelude of Early Reminiscences* (London: Bradbury and Evans, 1864–65, 3 vols), 2: 114–17.

[54] See Patricia Anderson, *The Printed Image and the Transformation of Popular Culture, 1790–1860* (Oxford: Clarendon Press, 1991), ch. 2.

[55] Valerie Gray, *Charles Knight: Educator, Publisher, Writer* (Aldershot: Ashgate, 2006); Knight, *Passages*, 2: 115–16; "Commercial History of a Penny Magazine", 420–21; Chatto *Treatise on Wood Engraving*.

[56] John Claudius Loudon, *An Encyclopædia of Gardening: Comprising the Theory and Practice of Horticulure, Floriculture, Arboriculture, and Landscape-Gardening, Including all the Latest Improvements; a General History of Gardening in All Countries; and a Statistical View of Its Present State, with Suggestions for its Future Progress, in the British Isles* (London: Longman, Hurst, Rees, Orme, and Brown, 1822), iv; Sarah Dewis, *The Loudons and the Gardening Press: A Victorian Cultural* Industry (Farnham & Burlington: Ashgate, 2014), ch. 1.

[57] *Literary Gazette*, 15 May 1824, p. 282.

[58] [John Claudius Loudon], [*Prospectus for the "Gardener's Magazine"*] ([London: Longman, Hurst, Rees, Orme, Brown and Green, 1826]), i–ii. The first issue was priced 2s. 6d. (not 5s. as sometimes stated) and the price rose to 3s. 6d. after the second issue was published.

[59] [John Claudius Loudon], "[Review of *Transactions of the Horticultural Society*]", *Gardener's Magazine* 2 (1827): 332–33, 414–44, on pp. 438–39.

[60] *Literary Gazette*, 11 February 1826, p. 473.

[61] Dewis, *The Loudons*, 73–74.

[62] [John Claudius Loudon], [*Prospectus for the "Magazine of Natural History*"], ([London: Longman, Rees, Orme, Brown, & Green, 1828], p. ii; Susan Sheets-Pyenson, "A Measure of Success: The Publication of Natural History Journals in Early Victorian Britain", *Publishing History* 9 (1981): 21–36, on p. 22.

[63] On Branston, Sowerby, Harvey, and Strutt, see *DNB* and Chatto, *Treatise on Wood Engraving*, esp. pp. 628–30. Reference to Strutt's involvement appears in a Longman advertisement in the John Johnson Collection, Bodleian Library, Oxford.

[64] "[Review of *The Animal Kingdom*, by Edward Griffith]", *Magazine of Natural History* 1 (1829): 275–77, on p. 276.

[65] Chatto, *Treatise on Wood Engraving*, 425.

[66] Secord, "Botany on a Plate"; Ray Desmond, "Loudon and Nineteenth-Century Horticultural Journalism", in *John Claudius Loudon and the Early Nineteenth Century in Great Britain,* ed. by Elisabeth B. MacDougall (Washington, D.C.: Dumbarton Oaks Trustees for Harvard University, 1980), 77–97.

[67] Frank Broomhead, *The Book Illustrations of Orland Jewitt* (Pinner: Private Libraries Association, 1995), 22–23.

[68] Sheets-Pyenson, "A Measure of Success", p. 24. See also David E. Allen, "The Struggle for Specialist Journals: Natural History in the British Periodicals Market in the First Half of the Nineteenth Century", *Archives of Natural History*, 23 (1996): 107–23 and Sheets-

Pyenson, "From the North to Red Lion Court: The Creation and Early Years of the *Annals of Natural History*", *Archives of Natural History*, 10 (1981): 221–49.

[69] 'Address to the Public', *Edinburgh Journal of Natural History*, 1 (1835): 1.

[70] Quoted in Secord, "Botany on a Plate", 35.

[71] Hooker discussed the audiences and costs of his new work at length with his publisher John Murray. See Murray Papers, MS. 40574, National Library of Scotland.

[72] *Magazine of Botany* 8 (1841): 265–66.

[73] Secord, "Botany on a Plate", 30–32.