Chapter 1
After Prometheus: Art and Technology in Early Modern Europe

Genevieve Warwick and Richard Taws

In a celebrated letter to Ludovico Sforza, Duke of Milan, Leonardo offered his complement of services as both an artist and an engineer. His stated abilities comprised a wide array of skills, from the construction of portable bridges, tunnels under rivers, methods of draining water for agricultural as well as military purposes; fortifications, weapons and armoured vehicles; architecture for both public and private uses; sculpture and casting in metal; and finally, painting, which he offered to do 'as well as any other'.[1]

The thousands of pages of Leonardo's notebooks provide evidence of the full range of interests and abilities that his letter claims, from hydraulic engineering to anatomy, astronomy, biology, optics, and art. Throughout the notebooks, his studies in art and technology sit side by side, often on the same sheet. Early sketches for the figural composition of a painting appear beside mechanical designs for water wheels, or machinery for the transport of heavy goods, regularly interspersed with notes of his further thoughts on their function and design. Other pages bring together the different facets of his varied interests in technology, for example, designs for industrial machinery and for astronomical investigation appear alongside visual technology deployed by an artist at work (*plate 1*). In the centre left of this sheet is the deep cylinder of a reciprocal displacement pump for moving water, driven by mechanized bellows, with a detail of the valve mechanism above. It configures one of the leading threads of Leonardo's notes, the study of water as a force of nature to be harnessed, as in Giorgio Vasari's account of Leonardo designing pumps 'to draw up water from great depths'.[2] To the right, a seated draughtsman sketches after a globe-shaped astrolabe or armillary sphere, an astronomical model of the circuits of the planets used to derive mathematical measures of space and time. Together the pump and the astrolabe demonstrate Leonardo's lifelong interest in the development of technologies as extensions of the human ability to master and study nature. In order to render the visual appearance of the astrolabe's spherical volume on the two-dimensional surface of a diagram, the draughtsman works by means of a further instrument apparently of Leonardo's devising, a perspectograph.[3] The artist looks through a sighting device to steady the eye onto a framed pane of glass placed before the object to be depicted. By this means the perspectograph allows the draughtsman to establish the outline and geometrical relation of the parts directly on the glass before him.[4] As an ensemble, the instrument guided and thereby extended the capacities of the human hand and eye in the accurate observation of volume, and facilitated the visual demonstration of this knowledge in a graphic model.

Detail from Leonardo, page of sketches including bellows for raising water and a draughtsman drawing after an astrolabe through a perspectograph, *Codex Atlanticus*, f. 5r, c. 1480 (*plate 1*).

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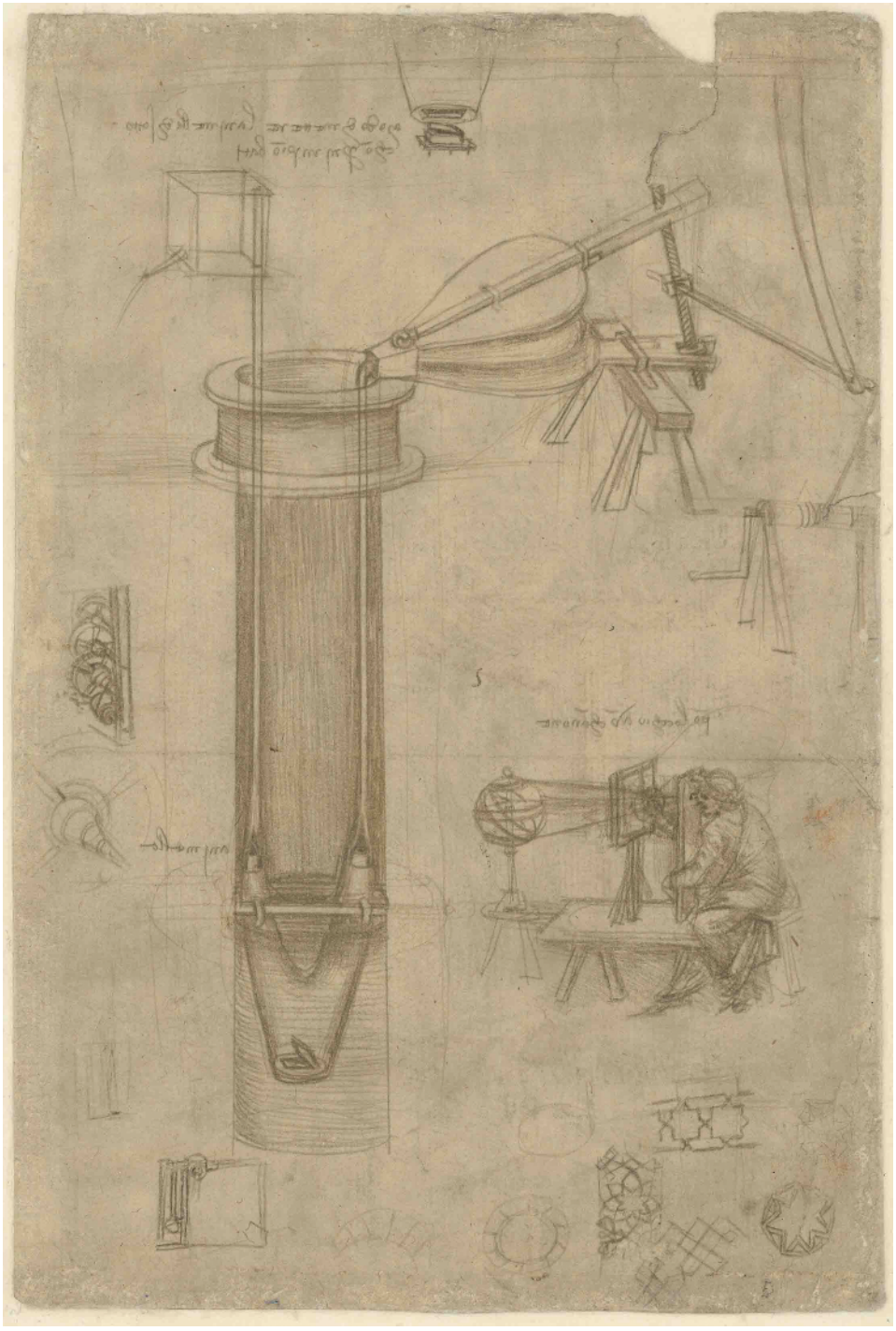

1 Leonardo, page of sketches including bellows for raising water and a draughtsman drawing after an astrolabe through a perspectograph, *Codex Atlanticus*, f. 5r, c. 1480. Silverpoint on prepared paper, 297 × 198 mm. Milan: Ambrosiana. Photo: Veneranda Biblioteca Ambrosiana.

Collectively, the sketches on the page testify to the growing role of early modern technology across all realms of human endeavour, from the pump and bellows of the hydraulic engineer to the artist's drawing frame. They demonstrate how skill as a draughtsman served the development of new technological designs, just as new technologies shaped the development of art.

As Leonardo's drawings and notebooks amply disclose, the writing of art's histories rests substantially, if for the most part tacitly, on an underlying account of technological change and development. This volume embarks on a history of that technological substrate as it pertains to the making and viewing of art in early

modern Europe, *c.* 1420–1820. That is to say, it examines artists' instruments, tools, machines, technologies, crafts, materials, skills, and techniques in their historic applications, to consider how they shaped the course of early modern art. The analytical endeavour is to knit together the history of early modern visual technology with the history of its art, and to make manifest the far-reaching connections between the two. The concern is a history of practice-based skills and devices intrinsic to early modern art's production and use, and in technology's relationship with a theoretical conceptualization of 'art' in the broader visual field.[5]

The temporal scope of the volume is framed by two metanarratives in the history of visual technology: the development of the printed image in the mid-fifteenth century; and of the photographically produced image in the early nineteenth century. The essays that follow do not treat the history of the print or the photograph as such, however, but rather the period that lies between, in order to map a distinctively early modern history of art and technology. Throughout, we use the term 'invention' advisedly, acknowledging Marc Bloch's longstanding critique of its artificial relief cut against the grain of a more gradual history of technological development.[6] We remain equally wary of a teleological or determinist history of technological change, and of the assumptions regarding a triumphal narrative of human achievement implicit in such an account.[7] Yet the model of history prompted by chronicles of 'invention', as marked by moments of fundamental rupture with the past that align with Thomas Kuhn's conception of the paradigm shifts distinguishing scientific 'revolutions', also helps delineate our field of study.[8] Both the print and the photograph facilitated a vastly greater diffusion of visual knowledge than ever before. Such historic augmentation of the circuits of knowledge exchange, then as now, fuelled intellectual developments and discovery in all aspects of human enquiry, including the artistic.

If our own information age is defined by the digital structures of electronic communication, early modern culture was inextricably bound to the medium of print. Printed text and image arose within a few years of each other in the mid-fifteenth century, credited to the German goldsmith, Johannes Gutenberg, who seemingly drew together a series of extant yet disparate technologies into a new machine that could print several thousand sheets a day. The ancient oil or wine press, coupled with the goldsmith's craft in fine metal carving, the late-medieval development of plentiful rag paper, and the recent formulation of more stable oil-based inks enabled Gutenberg's 'revolution'. Similarly, early photography developed from a coming together of two otherwise disparate technologies; on the one hand the pinhole camera through which to capture a reflected view of the world as an image, and on the other the chemical means to fix the effects of light exposure on paper. In both cases these technologies shared aesthetic resources with other media available at the time, while also producing forms of representation that were uniquely theirs, and which offered access to new ways of seeing, and enabled new forms of subjectivity. The greatly expanded flow of visual information facilitated by these technological breakthroughs worked to quicken the circulation of knowledge, and so the foundations of thought itself.[9]

To understand the far-reaching consequences of Gutenberg's legacy is pressing today, as we inhabit a new heuristic landscape of technologically enabled knowledge flow structured by the internet. From Gutenberg to Google, these technological 'revolutions' have brought about a fundamental reordering of the structures of knowledge in images and texts alike. Today, the parallel interfaces of Google Books and Google Images represent coterminous curations of textual and visual knowledge in a new *Encyclopédie* of the screen.[10] By contrast, the story of the print as a bearer of

2 Etienne-Claude Voysard after Claude-Louis Desrais, *L'homme de nature est un faible animal. Mais la Philosophie, aux Dieux le rend égal*, 1799. Etching and engraving, 15.7 × 9.7 cm. Paris: Bibliothèque nationale de France. Photo: BnF.

visual information, now increasingly superseded by the digital image, has become the historian's domain. If this is a relatively new prospect for the printed book, in many respects the printed image began the process of historical contingency some 150 years earlier, with the emergence of photography in all its varied early experimental forms.[11] Photography did not, of course, replace other media, rather functioning alongside and in many cases in collaboration with older technologies of visual representation, from painting to print.[12] Yet as Nicéphore Niépce, Louis Daguerre, and Henry Fox Talbot simultaneously developed the first photographs, the cultural position of the printed image changed irrevocably under the weight of this new, fully mechanized process of image reproduction.

The focus of this study, however, lies between these great shifts in the technological and material, but also ontological, status of the image. It is an interwoven history, marked by narratives of technological development, to be sure, but also vexed by instances of rupture, reversal, and obsolescence.[13] Our own historical position at the threshold of 'new media' in the arts rests on an awareness of this historical process as technological shifts restructure art itself in the digital medium.[14] Meanwhile, recent scholarship in the emerging field of media archaeology, and arguments for 'remediation' as an essential aspect of media change, as each new medium quotes from and refashions its predecessors, have demonstrated not only the persistence of past technologies for image-making in the present, but also the contemporaneity of historical images and processes that might otherwise have appeared obsolete.[15]

With contemporary visual practices and debates fully in mind, we are here committed to an examination of these issues within early modernity, and in their historical specificity. Rather than isolate the great gateposts of the print and the photograph, our intention is to open up for study the place of changing artistic technologies in the centuries that separated them, and thus the incursion of technology on artistic decision-making during early modernity. We are, then, concerned with the history of art's technologies from the Renaissance to the Industrial Revolution. The volume runs from the largely craft-based methods of the early Renaissance, to the wide plethora of automated viewing instruments and mechanical devices that characterized the years immediately preceding the advent of photography. The growing spread of technological marvels in all areas of human endeavour in the wake of early industrialization is, for example, given pictorial representation in a print by Etienne-Claude Voysard's *c.* 1800 print after Claude-Louis Desrais (*plate* 2). Balloons, parachutes, telegraphs, astrolabes, cannon, warships, telescopes, chemical experiments, and other 'philosophical' objects converge in this condensed allegorical reflection on both the wonder and the darker implications of new technologies for narratives of European imperialism, as laid bare in the background image of a plantation, and the focus on the Atlantic trade enabled by these devices.[16]

The array of technological artefacts under review in this volume likewise brings to light the scale of historical transformation at stake. For the early Renaissance, artistic production drew on a range of ancillary domestic crafts from which it borrowed materials and methods. In the eighteenth century, by contrast, definitions of visual technology resemble our own, signifying a spectrum of automated devices and viewing machines that mechanized the image in various ways. The encroaching instrumentalization of artistic practice across the period may be tied to broader historical processes of industrialization, but also to related developments in the history of science. For botany, astronomy and anatomy alike, an early modern


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Mais la Philosophie, aux Dieux le rend égal.
C. L. Desrais. del.
C. Voysard. Sculpsit.

epistemic shift from a largely text-based to a predominantly observation-based mode of study engendered through new lens-based visual technologies. Exemplified in the linked invention of the microscope and the telescope, these viewing devices in turn produced new visual paradigms in all aspects of learning, including the artistic.[17] Towards the end of our period, for instance, portraitist John Russell's pastel drawing of the gibbous moon, made between 1793 and 1797, seems to anticipate, in that most fragile of mediums, the permanence and fidelity of a 'photographic effect' by way of observation through a telescope obtained from one of his sitters, the royal astronomer Frederick William Herschel (*plate 3*).

To use the terms of Marcel Mauss's now-classic anthropological analysis, our study charts this broad temporal shift from manual techniques to mechanized technologies.[18] Yet the complexity of the historical material inevitably complicates any such trajectory, requiring us to attend both to change over time and to the contextualized analysis of specific moments within the longer spectrum, to survivals of techniques across broad stretches of time that coexisted alongside new instruments and technologies. Michel Foucault's far-reaching history of thought, which he termed an archaeology of knowledge, structured by a matrix of instruments, architectures, machines and procedures, draws together the terms 'technique' and 'technology' in ways that defy any easy distinction.[19] Similarly, the sociologist Jacques Ellul defined both technique and technology as constituted from an ensemble of methods designed for the greatest possible efficiency in their practical application, in any given historical period, thus undermining any straightforward developmental relationship between the two.[20] Furthermore, the historical range of early modern visual technologies expanded the possible meanings of technology 'proper', complicating our understanding of the relationship between technique and technology, and specifically in their visual forms.

Yet an overarching view of the historic development of tools, instruments and machines also signals key differences in the relationship between these terms over time. Turning back for a moment to our earliest human technological endeavours, archaeologists constate these in the material remains of archaic tools shaped by fire.[21] Such prehistoric technology is mythologized in the story of Prometheus, the Titan god who first lit fire for human application. The originary technology of the flame is manifest in the god's use of fire to fashion the first human figure from clay as the exordium of art. Just as fundamentally, the story testifies to the central role of art as the locus of material and technological experimentation.[22]

Thus as a term, technology encompasses an array of diverse, even conflicting definitions, from different disciplines, languages, and historical periodizations. This lexical complexity is, for example, central to Martin Heidegger's celebrated if dystopian 1954 essay on the ethical-philosophical 'question of technology', which draws on the dual meaning of '*Technik*' in German to encompass both technology and technique. At the core of his essay is an understanding of thought itself as a craft, thus erasing any neat separation between concept and instrumentation, or its more familiar art-historical designations of theory and practice.[23]

As a Promethean endeavour, this volume too is concerned with *techné*, those embodied forms of knowledge central to the manual/mechanical work of artistic production and use. Yet the history of visual technology is, following Heidegger, equally concerned with *logos*, or a theory of the image, and indeed with its changing conceptualization over time. The term 'techn[o]logy' seems to have first appeared in print in English in the early years of the seventeenth century, precisely to connote a form of knowledge comprising both *techné* and *logos*.[24]

3 John Russell, *The Face of the Moon*, 1793–97. Pastel on paper strained over a wooden stretcher, 60.7 × 50.4 cm. Birmingham: Birmingham Art Gallery. Photo: © Birmingham Museums Trust.

Thus the study of technology is not only concerned with practice-based forms of knowledge, but also with the changing conceptual paradigms that drive technological change. Analysis of technology brings together *homo faber* with *homo sapiens* – the human manufacture of tools and instruments as the material extensions of productive bodily labour, but also of patterns of thought and intention. It is the points of intersection between craft and concept that drive the development of new technological means. We may understand technological development as practical problem-solving, to be sure, but always within the folds of larger patterns of cultural enquiry.

Such expansive definitions of technology retain the meaning of techniques so resonant for the arena of artistic production in any period, as well as the instrumentation of its display. For the Renaissance workshop, at the outset of our study, art-making emerged through a process of thought predicated on the possibilities of the media at hand, a practice-based way of thinking through materials. From the mixing of paint solutions to the grinding of minerals and the weaving of canvas, these craft technologies were as fundamental to the making of early modern art as the grids, squaring and sighting devices that constituted the instruments of a mathematically theorized perspectival vision, or the mechanics that would later enable magic lanterns, panoramas, and early moving images. As technological prowess itself became a sign of wonder, machinic visibility as part of the presentation of an art object was often enhanced. Yet there is also evidence of the suppression of art's technical and technological means, its very invisibility understood as a token of art's skill.

By the end of the eighteenth century, as technology became more indelibly associated with industrialization, it came to be viewed as counter to the 'true' aims of art, a critique that became ever more pronounced as the nineteenth century progressed. Yet such commentaries only served to highlight technology's interface with a developing social critique of the 'machinic', in the arts as for society more broadly. As the writings of Jean-Jacques Rousseau embody, and later the works of the Arts and Crafts movement, the heralding of new technologies was met with cultural anxiety as much as industrial acclaim.[25]

How then may this historic interplay of social critique, analysis and definition be brought to bear on the study of early modern technologies pertaining to art? Like Leonardo's perspectograph, the development of visual technology in the realm of art was linked to a technical history of the image as the means to instrumentalize the replication of nature. The role of artistic technology was understood as the method by which to render an ever-more exacting imitation of the visible world in the form of art. At the same time, there was a marked shift in the means to achieve this, from a predominantly but certainly not exclusively technical paradigm of manual execution in the early fifteenth century, to an increasingly mechanical or industrialized instrumentation of art over the course of the period covered. Moreover, there was a discernible shift towards technologies concerned with the display of art – phantasmagoria, stereoscopes, and other apparatuses – in addition to its production. Thus our study moves spatially as well as temporally, between art-making and art-viewing, from the craftsman's workshop to the collector's gallery, the artist's studio to civic space, the scientist's laboratory and the fairground's popular entertainments. It also takes into account those technologies not directly implicated in the making or display of art, but which had a bearing on it nonetheless, often in unanticipated or unexpected ways. Above all, it traces a history of early modern art in its complex relationship with technology, as forms of instrumentation to be sure, but

also as systems of knowledge. In so doing, it lends new visibility to the often occluded history of art's means, and situates the study of early modern art and technology within a complex network of historical relations – between practice and concept, mechanics and epistemes, *ars* and *scienza*.

The following essays in this volume all, in different ways, contribute to a new analysis of the role of visual technologies in the development of early modern art. Together they map a history of visual instrumentation devised for the making and viewing of art interwoven with a broader historical shift towards industrial modernity. Individually, they signpost new avenues for enquiry, singling out those objects and images possessed of a particularly dense, heightened ability to break fresh ground in our understanding of early modern developments in art and technology. Four opening essays study a range of early modern artists' instruments. The Renaissance artist's 'recipe book' is Pamela H. Smith's example, a collection of 'how-to' instructions in materials and techniques. Smith's mode of analysis in itself instantiates *techné*, conducted through practice-based reconstructions of the recipes undertaken as an aspect of graduate training, much like the Renaissance workshop. The example of artists' mannequins and maquettes, used by Tintoretto, Poussin, and Vermeer among others, allows Jan Blanc to argue for a finely nuanced understanding of artistic process as a coupling together of working 'from life' and from art-historical memory. Genevieve Warwick takes up the case of the mirror, both as a workshop instrument used to translate the painter's view of the world into a two-dimensional surface, and as a motif within painting to signify the painter's art. Meanwhile, Amy Knight Powell takes up the telescopic view of landscape manifest in roundel paintings to argue for a new attention to the representation of distance in painting at the moment in which prosthetic devices for the extension of human vision first appeared.

The ensuing five essays take an individual painting or monument as their focus, collectively demonstrating a growing emphasis on technologies of artistic display. Giulia Martina Weston's study of Niccolò Tornioli's *c.* 1645 depiction of astronomers binds the representation of astronomical viewing devices within the painting to early modern collections of such instruments of visual wonder, to argue for a renewed defence of the role of epistemic images in the immediate wake of Galileo's death. Etienne Jollet considers pictorial representations of the casting and elevation of the colossal bronze equestrian monument to Louis XIV by François Girardon at the Place Vendôme, completed in 1699. These images formed part of a widespread interest in technical knowledge surrounding artistic production, but also of royal power, through the patronage of mechanical technologies understood as manifestations of the marvellous within a broader early modern culture of *theatrum mechanicum*. Hanneke Grootenboer also takes up the example of the mechanical, through a small automated landscape painting framed by a display of clock faces produced in 1739 for a *Cabinet de Mécanique*, as a pictorial commentary on Descartes' disquisition on the nature of the universe as clockwork. Joseph Wright of Derby's celebrated pictorial representation of a scientific experiment, *The Bird in an Air Pump* of 1768, is the subject of Bryan Wolf's essay, newly analysed as a primer in the ideological and pedagogical underpinnings of visual observation and the cultural power of science. Ann Bermingham interrogates Philippe de Loutherbourg's Eidophusikon, a public 'moving picture' attraction staged in 1781 in a London square, and fêted for its combination of technical accomplishment and mimetic visual magic at the threshold of a new, technologically driven, display culture of images in motion. By contrast, Richard Taws studies an historical instance of a new information

technology in post-revolutionary France, that of optical telegraphy, which for some fifty years was a highly visible if ostensibly 'secret' means of disseminating political news and messages in the charged years during and after the French Revolution. Finally, Barbara Stafford's coda takes us from early modern technological wonder to contemporary instances of technological fascination in the visual realm. It dwells on the changing quality of human mental attention in relation to a history of new technological devices in the digital age. Tacitly recalling Ernst Kapp's foundational treatment of technology as prosthetic, it acknowledges this Aristotelian view of technologies as 'the extensions of man', in Marshall McLuhan's phrase. Thus the hammer is an extension of the fist, be it of a sculptor or a carpenter; the pencil and paintbrush of the artist's hand; while eyeglasses, microscopes, telescopes and lenses of all kinds extend the power and functions of the eye, both artistic and scientific. Technology as such, Leo Marx reminds us, makes nothing happen – its agency lies in its human applications.[26] Stafford concludes with current considerations concerning digital memory and electronic data, leading her to reflect on how the computer has now seemingly become an extension of the brain itself. As Leonardo well understood, technologies could augment the capacities of hand and eye in the quest to know, and thus master, the elemental forces of nature. In this regard, he likewise recognized in technology a means to extend knowledge, and thus the mind.[27]

Notes

Warm thanks are extended to all our contributors for their essays and interest in this project, and especially to each other for sharing the editorial collaboration, to Sam Bibby for his manifold patience, and to the attentive contributions of our anonymous peer reviewer.

1 *Codex Atlanticus*, f. 1082r, Milan: Biblioteca Ambrosiana, c. 1480s; cited in Martin Kemp, *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat*, New Haven, CT and London, 1990, 170–1.

2 Giorgio Vasari, *Le vite* …, ed. Luciano Bellosi and Aldo Rossi, Turin, 1986, 550.

3 On the diagram as a means of producing technical and artistic knowledge in early modernity, see John Bender and Michael Marrinan, *The Culture of Diagram*, Stanford, CA, 2010.

4 B. N. Ms. Ital. 2038, f. 24r, Paris: Bibliothèque de l'Institut de France, 1480; cited in *The Literary Works of Leonardo da Vinci*, ed. Jean Paul Richter, Oxford, 1977, vol. 1, 317.

5 See Horst Bredekamp, *The Lure of Antiquity and the Cult of the Machine: The Kunstkammer and the Evolution of Nature, Art and Technology*, trans. Allison Brown, Princeton, NJ, 1995; Horst Bredekamp, Vera Dunkel and Birgit Schneider, eds, *The Technical Image: A History of Styles in Scientific Imagery*, Chicago, IL, 2015; Martin Kemp, *The Science of Art: Optical Themes in Art from Brunelleschi to Seurat*, New Haven, CT and London, 1990; Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century*, Cambridge, MA and London, 1992; Barbara Maria Stafford, *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education*, Cambridge, MA and London, 1994; Barbara Maria Stafford and Frances Terpak, *Devices of Wonder: From the World in a Box to Images on a Screen*, Los Angeles, CA, 2001; Caroline A. Jones and Peter Galison, eds, with Amy Slaton, *Picturing Science, Producing Art*, London and New York, 1998; Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution*, Chicago, IL and London, 2004; Alina Payne, ed., *Vision and its Instruments: Art, Science, and Technology in Early Modern Europe*, University Park, PA, 2015. On pre-modern technology and culture more broadly, see Lewis Mumford, *Technics and Civilization*, New York, 1934; Sigfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History*, New York, 1948; Lynn T. White Jr, *Medieval Technology and Social Change*, Oxford, 1962; David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*, Cambridge, 1969; Lorraine Daston, *Biographies of Scientific Objects*, Chicago, IL and London, 2000; Lorraine Daston, *Histories of Scientific Observation*, Chicago, IL and London, 2011; and Lissa Roberts, Simon Schaffer and Peter Dear, eds, *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, Amsterdam, 2007.

6 Marc Bloch, 'Les inventions médiévales', *Annales d'histoire économique et sociale*, 7, 1935, 634–43.

7 See Lisa Gitelman, *Always Already New: Media, History, and the Data of Culture*, Cambridge, MA, 2006; and the essays in Lisa Gitelman and Geoffrey B. Pingree, eds, *New Media, 1740–1915*, Cambridge, MA, 2003. Gitelman argues that claims to novelty are neither fixed nor inevitable, for all media were once themselves 'new', thus complicating claims for technological progress and agency.

8 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, Chicago, IL, 1962.

9 See the classic study by William M. Ivins Jr, *Prints and Visual Communication*, Cambridge, MA, 1953; and Roger Chartier, *The Culture of Print: Power and the Uses of Print in Early Modern Europe*, Princeton, NJ, 1989.

10 Jay David Bolter, *Turing's Man: Western Culture in the Computer Age*, Chapel Hill, NC, 1984.

11 The historical study of the invention of photography has been instrumental to the analysis of the technological conditions of image production more broadly, and to the revival of Walter Benjamin's now-classic 1936 essay, *The Work of Art in the Age of Mechanical Reproduction*, London, 2008. From a vast bibliography, see in particular: Paul Valéry, 'And then came Daguerre…', in *The Collected Works of Paul Valéry*, ed. Roger Shattuck and Frederick Brown, Princeton, NJ, 1970, vol. 2, especially 159; and Victor Burgin, ed., *Thinking Photography*, London, 1982. More recently, the multiple 'inventions' of photography have been the subject of revived scholarly interest. See, for example, the essays in Tanya Sheehan and Andrés Zervigón, eds, *Photography and Its Origins*, New York, 2015. For a critique of 'photographic exceptionalism', see Stephen Bann's essay, 'Against photographic exceptionalism', in that volume, 94–103.

12 See Stephen Bann, *Parallel Lines: Printmakers, Painters, and Photographers in Nineteenth-Century France*, New Haven, CT and London, 2001.

13 Michael Werner and Bénédicte Zimmermann, 'Vergleich, Transfer, Verflechtung. Der Ansatz der Histoire croisée und der Herausforderung des Transnationalen', *Geschichte und Gesellschaft*, 28, 2002, 607–36.

14 See James Elkins, *The Domain of Images*, Ithaca, NY, 1999; James Elkins, *Six Stories from the End of Representation: Images in Painting, Photography, Astronomy,*

Microscopy, Particle Physics, and Quantum Mechanics, 1980–2000, Stanford, CA, 2008; and Julian Stallabrass, *Internet Art: The Online Clash of Culture and Commerce*, New York, 2003.

15 See Jay David Bolter and Richard Grusin, *Remediation: Understanding New Media*, Cambridge, MA, 1998; Siegfried Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means*, Cambridge, MA, 2008; and for an introduction to these issues, Jussi Parikka, *What is Media Archaeology?*, Cambridge, 2012.

16 On the background to the development of many of these technologies, see Charles Coulston Gillispie, *Science and Polity in France: The Revolutionary and Napoleonic Years*, Princeton, NJ, 2004.

17 See Svetlana Alpers, *The Art of Describing: Dutch Art of the Seventeenth Century*, Chicago, IL, 1984; Catherine Wilson, *Early Modern Philosophy and the Invention of the Microscope*, Princeton, NJ, 1995; Eileen Reeves, *Painting the Heavens: Art and Science in the Age of Galileo*, Princeton, NJ, 1997; and Domenico Laurenza, *Art and Anatomy in Renaissance Italy: Images from a Scientific Revolution*, New Haven, CT and London, 2012.

18 Marcel Mauss, *Techniques, Technology and Civilisation*, ed. Nathan Schlanger, New York and Oxford, 2006

19 Michel Foucault, *Power/Knowledge: Selected Interviews and Other Writings*, New York, 1980

20 Jacques Ellul, *The Technological Society*, New York, 1964, xxv.

21 Earl Swanson, ed., *Lithic Technology: Making and Using Stone Tools*, The Hague, 1975.

22 Hesiod, *Theogony*, ed. M. L. West, Oxford, 2008, 507–616; Aeschylus, *Prometheus Bound: The Complete Greek Tragedies*, ed. David Greene and Richmond Lattimore, Chicago, IL, 1960, vol. 1, 309–51.

23 Martin Heidegger, *The Question Concerning Technology and Other Essays*, New York, 1977. For a sustained engagement with Heidegger's thought on these issues, and on the repressed role of technics in the history of philosophy, see Bernard Stiegler, *Technics and Time*, 3 vols, Stanford, CA, 1998–2010.

24 'Technology', in C. T. Onions, ed., *The Oxford English Dictionary on Historical Principles*, Oxford, 1972, 2140.

25 See, for example, Jean-Jacques Rousseau, *Discourse on the Sciences and Arts*, in Roger D. Masters and Christopher Kelly, eds, *Collected Writings of Jean-Jacques Rousseau*, Hanover, NH and London, 1992, vol. 1; and William Morris, 'Art and Socialism', in G. D. H. Cole, ed., *William Morris: Stories in Prose, Stories in Verse, Shorter Poems, Lectures, and Essays*, New York, 1934, 624–45.

26 Leo Marx, 'Technology: The emergence of a hazardous concept', *Technology and Culture*, 51: 3, July 2010, 577.

27 Ernst Kapp, *Grundlinien einer Philosophie der Technik: Zur Entstehungeschichte der Kultur aus neuen Gesichtspunkten*, Brauenschweig, 1877; Marshall McLuhan, *Understanding Media: The Extensions of Man*, London, 1964. The influential work of Friedrich Kittler offers a more pessimistic, anti-humanist counter-argument to this position. Arguing against McLuhan's 'extensions of man', for Kittler technology is autonomous and directs human activity, rather than the other way around. See, especially *Discourse Networks 1800/1900*, Stanford, CA, 1990; *Gramophone, Film, Typewriter*, Stanford, CA, 1999; and, with particular reference to the visual, *Optical Media: Berlin Lectures 1999*, Cambridge, 2009.