Picturing Machines 1400–1700 edited by Wolfang Lefèvre

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Picturing Machines derives from a conference on Renaissance engineering drawings hosted by the Max Planck Institute for the History of Science in the summer of 2001. Divided into five sections, the volume's nine contributions address specific drawings of machines as well as the modes and means of visual representation available to their creators. Rather than the technical subject of machines, the common denominator that binds the papers together is the drawings, which these authors consider not as mere illustrations of the verbal text but as ideas separated and partially independent of it. Following on the heels of *The Power of Images in Early Modern Science*—another collection of essays from a Berlin conference that Wolfang Lefèvre helped organize and edit [2003]—*Picturing Machines* is the latest contribution from the movement aiming to reconsider the role of images and visual representation within the intellectual and cultural dimensions of the history of science. Approaching drawings and printed figures from a variety of perspectives ranging from the social to the purely technical, these essays represent the effort of historians of science to mark their own territory within the emerging field of visual studies of early modern culture. In what follows I provide a brief summary of each contribution while allowing more space to those that I believe would be of most interest to the readers of this journal.

Beyond an enlightening introduction which provides a useful overview of the volume as well as of the topic, Lefèvre also appends a short forward to part 1 in which he defines 'machine drawings'. Different from the ubiquitous depictions of technical objects and representing only a limited subset of technical drawings, machine drawings are pragmatically defined as drawings 'traced or used by technicians in

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the pursuit of their professional life or derived from such practitioners' drawings' [13]. Thus, rather than devise a definition based on visual and intellectual properties of machine drawings, Lefèvre privileges their makers' social status and operative cultural space. In fact his definition reflects the conclusions of Marcus Popplow's essay comprising part 1 and entitled 'Why Draw Pictures of Machines? The Social Contexts of Early Modern Machine Drawings'. Arguing from later 16th- and early 17th-century examples, Popplow identifies four contexts in which machine drawings were employed during the early modern period. First, as is aptly exemplified by *teatri di macchine*, engineers used drawings of machines to present their devices to a broader, non-expert public. Second, the 16th century also saw the emergence of a distinction in social-standing between engineers and technicians; drawings were drawn by the former in order to provide 'blue-prints' for the latter who then built the actual machines. Third, engineers drew machines—theirs as well as their colleagues'—to keep a private record to serve as a reference and inspiration for future projects. Fourth, through drawings engineers analyzed the machines' workings from a 'theoretical' perspective. Popplow's categories adequately describe the contexts and, therefore, the audiences and purposes, in which machine drawings appeared during the Renaissance; they create a cultural identity for machine drawings that is unavailable for other coeval forms of visual representation of scientific and technical subjects, such as botanical, anatomical, or mathematical drawings. Undoubtedly, his 'Linnean' classificatory effort will provide valuable points of reference for those studying specific groups of drawings.

In addition to Reiner Leng's investigation of the pictorial language developed by German gunmakers to communicate with their colleagues and apprentices, part 2 includes an important essay by David McGee. In 'The Origin of Early Modern Machine Design', he presents four short case studies on the drawings of Villard de Honnecourt, Guido da Vigevano, Konrad Kyeser, and Mariano Taccola respectively, in order to support several general and noteworthy methodological and historiographic conclusions. The analysis of drawings by the first two engineers allows McGee to conclude that early Renaissance machine representations are neither naive nor incomplete. Instead, he recommends that we read and interpret these drawings primarily as an effective means of communication within a

process involving two creative minds endowed with technical expertise. Building a machine required adjustments specific to the site and depended on the availability of materials in the field. Because of these contingent and unpredictable factors, drawings explicated crucial design principles rather than providing the equivalent of modern blueprints inclusive of measurements and specifics for all parts and materials. The visual language of these drawings functioned perfectly within the technical domain of those who built machines, a domain within which the coexistence of multiple viewpoints or inconsistencies of perspective within a drawing were clarifying and advantageous rather than confusing. However, as soon as princes and patrons became involved in the construction of machines—mainly when it came to funding—the visual representation of those machines changed, as is already evident in Kyeser's 'proto-perspectival' renditions that include realistic backgrounds and human operators. Taccola's sketches take this process a step further by dispensing with multiple viewpoints while also making the dimensions uniform, which helped to produce three-dimensionally coherent images of machines set in a natural, believable space. Yet it is noteworthy that this change was not limited to presentation drawings: Taccola also rendered his machines in this way in his personal sketches. Most importantly, his drawings clarify that a 'realistic' visual representation did not imply that machines were realistic or that their workings complied with real physical constraints. This latter point convinces McGee that Renaissance engineers should not be construed as 'conceptual builders of the scientific revolution' [84].

The essays by Pamela Long and Mary Henninger-Voss comprise part 3 and address aspects of the relationship between drawings and knowledge, knowledge created as well as assumed. In her 'Picturing the Machine: Francesco di Giorgio and Leonardo da Vinci in the 1490s', Long sheds light on how drawings of machines became a means for investigating natural philosophical problems. The figures in Francesco's *Trattato* reveal his concerns with the investigation of power from a technical perspective, while Leonardo's *Madrid Codex* 1 uses drawings to study the subject of natural motion as it pertained to the *scientia de ponderibus*. Most importantly, Long shows that in both cases texts and images function in symbiosis. While considering the readers' perspective, Henninger-Voss' study of fortification drawings reveals that the theoretical basis of the visual language shared

by all of those involved with military architecture, from patrons and generals to architects and stone masons, was founded upon geometry and its applications in those sciences subalternated to mathematics. Training in these disciplines provided advanced skills in visual analysis and in reasoning by means of figures and diagrams.

The three papers of part 4 shift the focus to the development of geometric techniques used for drawing machines. Filippo Camerota investigates the codification of the rules for technical drawings that, by the 18th century, became known as 'descriptive geometry'. The progression he describes begins with 15th-century linear perspective, which is subsequently integrated with the orthographic, shadow, and double projections. Lefèvre's own article in the volume instead details the introduction of the combined view, a technique first developed within artistic and architectural contexts at the beginning of the 16th century by Albrecht Dürer and Antonio da Sangallo the Younger. Finally, Jeanne Peiffer considers Dürer's integration of optical laws of perception in his technical drawings. Although this element taken from the science of optics was not retained by technicians among Dürer's immediate followers, it was incorporated in the high tradition from Daniele Barbaro onward, throughout the 17th century.

The volume's concluding section comprises Michael Mahoney's 'Drawing Mechanics', an essay interesting for various reasons. *In primis*, while presenting Huygens' notes and sketches to understand the scientist's confrontation with the clockmaker Isaac Thuret, Mahoney offers exemplary analyses of drawings from the perspective of the history of science: he actually analyzes the visual evidence in detail, working through the drawings line by line. More importantly, in the opening pages Mahoney poses questions and underscores issues that should remain firmly in the mind of all scholars interested in the interaction between art and science in the early modern period. Even though the points that he makes relate strictly to the science of mechanics, they also expand and update the conclusions he presented long ago in the essay that doomed Samuel Edgerton's argument for a pivotal role of Renaissance linear perspective and naturalism in the scientific revolution [Mahoney 1985, 198–220]. After demonstrating that by the later 17th century those concerned with the theoretical aspects of mechanics abandoned visual representation as irrelevant to a mathematical understanding, Mahoney rightly warns against reading

into Renaissance machine drawings rudimentary theoretical principles of the science of mechanics that were developed only in the 17th and 18th centuries. Moreover, he is sceptical about treating the drawings of Renaissance engineers as genuine moments of scientific inquiry, and about their impact on the development of scientific theories. However, rather than questioning the potential import of the study of machine drawings for the history of the scientific revolution, Mahoney's healthy scepticism should serve as a call to understand better the development and impact of the visual reasoning and visual thinking skills shared not only by those who created and read machine drawings, but also by those who drew and reasoned through images in pursuing natural philosophical issues.[1] Although the epistemological limitations of visual representation became apparent over the course of the 17th century, many Renaissance intellectuals truly hoped that images could serve as effective tools for understanding nature.

In summary, this volume offers valuable insights and provides much food for thought not only to those interested in the history of machines and mechanics, but also to all scholars of early modern science and its interaction with art in the Renaissance. In spite of the recurring editorial glitches, MIT press should be praised for offering an important book at such an affordable price, and for ensuring that the volume contains excellent reproductions of all the images referred to by each contributor.

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[1] Mahoney cites a passage from a letter of Ludovico Cardi da Cigoli to Galileo Galilei in which the painter explains Christopher Clavius' refusal to believe in the Moon's roughness by citing the Jesuit's lack of '*disegnio*'. (Such an accusation is obviously completely unfounded.) In the painter's view—which he expects Galileo to share—mathematicians should be capable of reasoning from graphic, visual evidence. Moreover, given that the issue at stake concerned the properties of a celestial body, the ability to arrive at conclusions by means of visual analysis and demonstrations was probably expected also of natural philosophers. For the original letter, see Favaro 1890–1909, 11.167–169.

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