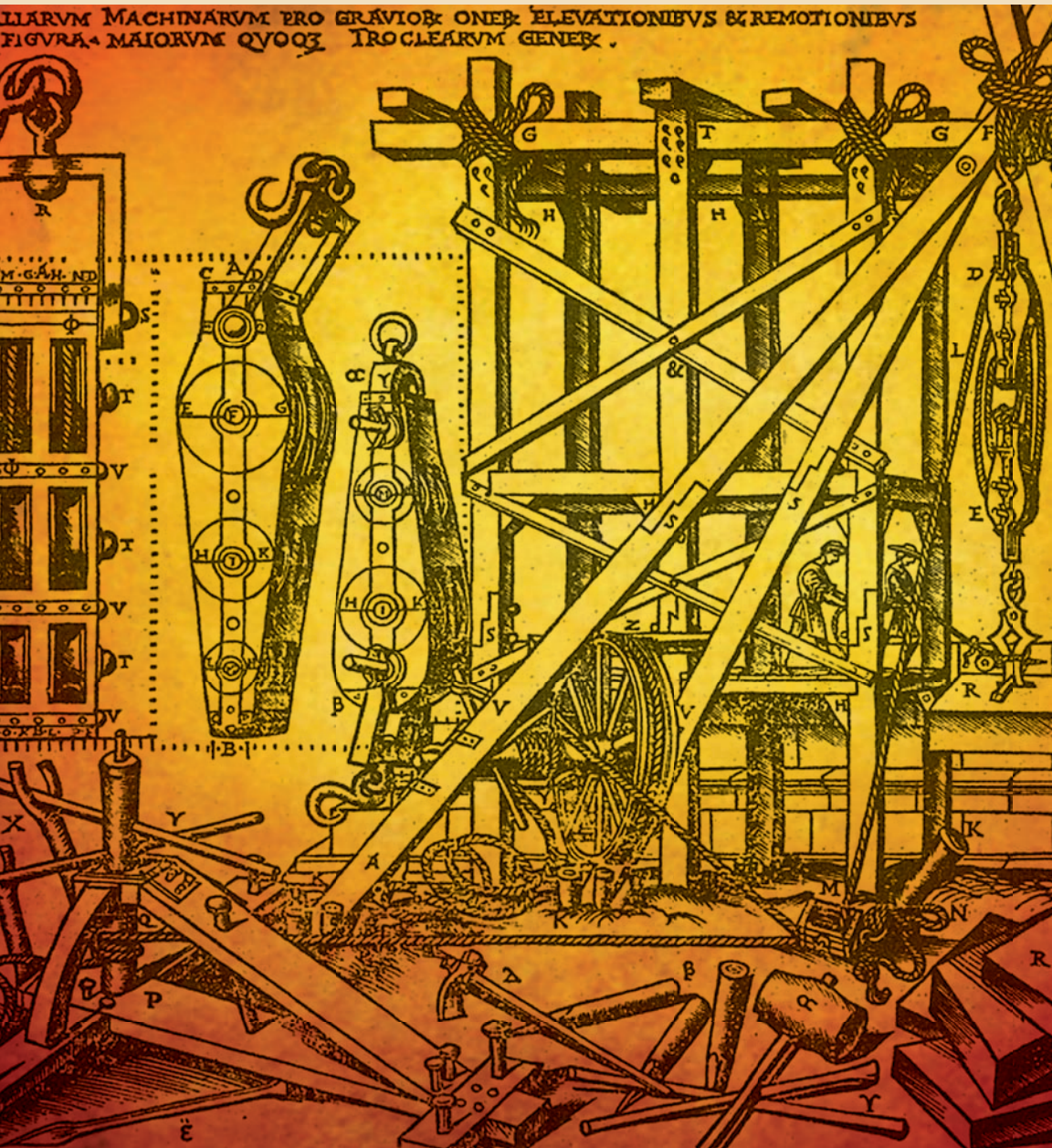
Artisan/Practitioners and the Rise of the New Sciences, 1400–1600

PAMELA O. LONG



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PREFACE

This book came out of the public lectures that I gave as the Horning Visiting Scholar at Oregon State University in April 2010. Three of the essays in this book are a direct result of the lectures, while a fourth, on the Vitruvian tradition, is an addition. It was a great pleasure to spend the week at Oregon State to give lectures to wonderful, inquisitive audiences, to talk extensively throughout the week with faculty and graduate students in the history department and in other departments of the university, and to participate in seminars and classes. I especially thank Horning Professors Anita Guerrini and David Luft, who invited me, warmly welcomed me, and made my stay a memorable one. I thank Lisa Sarasohn and Jacob Hamblin for inviting me to participate in their classes and seminars, Michael Osborne and Anita Guerrini for their welcoming hospitality, and Elissa Curcio for making and facilitating numerous arrangements.

One might think that delivering a series of three lectures would be a simple matter of organizing what one knows and delivering that knowledge in a rhetorically effective way to a (hopefully) receptive audience. This was hardly the case with these lectures on artisan/practitioners and their influence on the new sciences. It is true that I have been thinking about and investigating premodern artisans—people whose work life was centered on the skilled manipulation of materials in order to fabricate objects, and those who engaged in complex material practices such as agriculture or navigation—and artisanal culture for most of my scholarly life. The intense months of preparation for the lectures, however, involved new primary research and the assessment of much recent scholarship on relevant topics. Preparing for the lectures also provided an unexpected opportunity to step back and to reassess my own previous work and thinking on the topic and to create a new synthesis that went beyond that work.

During the months of transforming the lectures into chapters of this book, I was supported by National Science Foundation grant #0849158. The entire manuscript was critically read by Horning Professor Emerita Mary Jo Nye; Anita Guerrini; my sister, master writer and poet Priscilla Long; and astute reader Bob Korn. Together they saved me from errors and greatly helped improve the work. Finally, I thank Teresa Jesionowski for superb copyediting that saved me from many errors, and I thank the acquisitions editor of Oregon State University Press, Mary Elizabeth Braun, and managing editor, Jo Alexander, who brought the book to press with efficiency and care.

INTRODUCTION

Artisanal Values and the Investigation of Nature

A long-standing issue in the history of science can be framed as a question: Did artisan/practitioners influence the development of the new sciences? By the expression "artisan/practitioners," I refer to a broadly diverse group of skilled artisans such as weavers and instrument makers; architect/engineers involved in the design and construction of buildings, bridges, and the like; and practitioners such as farmers and navigators.[1] Through the lens of this one issue, which is a fundamentally important one, this book treats a series of complex, multifaceted, and long-term developments, traditionally referred to as the "scientific revolution." The people contributing to this development did not use the phrase "scientific revolution" but often referred to their own work as a "new science." For example, Galileo Galilei (1564–1642) called one of his most important books *Discourse on the Two New Sciences* (referring to the strength of materials and the motion of objects). It is this term, commonly used in the sixteenth and seventeenth centuries, that I use throughout.

The new sciences are usually considered to have developed on the European continent and in England from the mid-sixteenth century through the seventeenth century. A key initial event was the publication in 1543 of the *De revolutionibus* by Nicholas Copernicus (1473–1543), and a concluding highpoint is often considered to be the publication of the *Principia Mathematica* (1687) by Sir Isaac Newton (1643–1727). This book begins earlier, around 1400, and ends around 1600. I argue that in this two-hundred-year period, the empirical values that were intrinsic to artisanal work came to be embedded within a broader European culture. Near the end of this period, around the mid-sixteenth century, new ideas about the cosmos and the natural world began to emerge. New kinds of

questions began to be asked, and new methods began to be utilized to investigate nature.[2]

Changes brought by the new sciences must be understood against a background of the Aristotelianism and scholasticism of the medieval universities. The *studium generale*, as the medieval university was called, emerged in the early thirteenth century. Professors in the universities taught about the cosmos and the natural world, or "natural philosophy," by focusing on Aristotle and Aristotelian texts and commentaries. Such texts formed a rich tradition to which there was no equivalent in terms of depth, breadth, or sophistication. It included time-tested views concerning the structure of an Earth-centered cosmos, as well as a material and causal understanding of substances, and a coherent explanation of motion and change. In addition, this tradition contained within it a set of methodologies or ways of approaching the investigation of the natural world.[3]

Substantial scholarship underscores the depth and richness of this Aristotelian natural philosophy, as well as its ability to develop and change. It was an important part of the educational system until at least the end of the seventeenth century.[4] At the same time, though, from about the mid-sixteenth century, new ideas and approaches concerning the structure of the cosmos and concerning phenomena such as motion and substance began to be put forward. Innovative approaches and new instruments encouraged the practice of observation—observation of plants and animals, stars and planets. It is a distortion, however, to say that Aristotelianism was replaced by the new sciences in this era; rather, they coexisted, sometimes in fruitful dialogue and synchrony, sometimes in polemical opposition.

Changing views about how the world was constructed and how it should be investigated came in the wake of social, economic, and political changes that had occurred in medieval and late medieval Europe. The rise of the cities; the development of commercial capitalism and long-distance trade; the development of large-scale industries such as textiles, armaments, and mining; the immense expansion of overseas markets;[5] oceanic explorations and the discovery of lands new to Europeans; new

knowledge about never-before-heard-of flora and fauna and unknown peoples;[6] the increasing political and social importance of princely courts;[7] the invention of movable type and printing and the subsequent great expansion of books and pamphlets of all kinds;[8] conspicuous consumption among elites and the parallel expanding manufacture of luxury goods; the construction of massive palaces and other buildings and their ornamentation;[9] the increased importance of visual culture and the rising status of the visual arts aided by the invention of artists' perspective[10]—all this brought with it a growing valuation of things, of objects, and often, an appreciation of the skill and knowledge of the people who made those objects. These closely interrelated complex historical developments influenced the ways in which the world was approached, investigated, and understood.

The new sciences put forth innovative ideas about the structure of the cosmos and other aspects of the natural world. For example, in his *De revolutionibus*, Copernicus rejected the geocentric model of the cosmos and proposed a heliocentric model. Tycho Brahe (1546–1601) proposed a third, compromise model, a geoheliocentric cosmos in which the moon and the sun revolve around the earth, while Mercury, Venus, Mars, Jupiter, and Saturn revolve around the sun, and the fixed stars around all.[11] New approaches were also adopted in other areas such as anatomy, physics, and natural history.

The new sciences entailed particular discoveries and new ideas, and, in addition, changes in the kinds of questions asked and in the methods used to answer those questions. Investigators increasingly adopted a variety of empirical approaches and values as relevant to knowledge about the world—an appreciation for the knowledge acquired by hands-on manipulation and the use of instruments; the practices of direct observation and experimentation; methods of precise measurement and other forms of quantification; and a positive valuation of individual experience. These values and practices closely resembled those held by contemporary artisans and practitioners such as painters, sculptors, carpenters, weavers, potters, architect/engineers, mariners, apothecaries, and farmers.[12]

In the 1920s, as the modern discipline of the history of science developed, this sixteenth-century overlap and coincidence of the values and practices of artisans, on the one hand, and investigators of the natural world, on the other, suggested to some that artisans had significantly influenced the development of the scientific revolution. Other historians vociferously disagreed. Since the 1980s, the issue has reemerged but framed in a very different way. The history of this issue and the issue itself are the twin subjects of this book.

"Artisan/practitioners" were men and women who worked with their hands in craft production (for example, carpenters, weavers, and instrument makers) or carried out complex practical tasks such as farming or navigation. A characteristic of the medieval period in general is that the world of crafts and the world of learning existed in quite separate realms. The study of the natural world occurred in the universities and was called natural philosophy. Craft practice involved a hands-on process in which apprentices learned by doing and making, sometimes formally under an apprenticeship contract regulated by a guild and sometimes informally as part of a family unit. Crafts such as spinning, weaving, and painting and practices such as agriculture and navigation were learned under the guidance of a skilled practitioner, often an older family member. In some cases writings surrounded craft activities, such as records and accounts kept, regulations for the craft, and specifications created by patrons for particular works, and there may have been other kinds of communicative and mnemonic devices such as drawings on paper or models made out of wood. The usual activity of craft practice, however, was carried out by making something or carrying out some physical task. Any instruction was usually oral and was provided in one of the vernacular languages, whether Italian, French, German, English, or some other language.[13]

In contrast, reading, writing, and teaching at the universities in the Middle Ages were conducted in Latin. University instruction in natural philosophy as well as in other topics was based on two main activities, the lecture (*lectio*) and the disputation (*disputatio*). In the *lectio*, the professor lectured and commented on authoritative books

that were prescribed by regulations that governed the university. These books included ancient texts such as those by Aristotle, sometimes with additions and explications by medieval commentators. Edward Grant describes the ways in which the lecture developed over several centuries—it consisted of the summary of one or more texts, and a discussion or commentary, sometimes including reference to previous commentaries. The disputation, or *disputatio,* took several forms but always involved one or more questions (the *quaestio*). Often students under examination would be given opposite sides of a question to defend. The resolution of the question, called the determination, or *determinatio,* would be summarized by the presiding master.[14]

Impinging on this world of university scholasticism, a new intellectual movement that came to be known as humanism arose in the fourteenth century—most notably in the writings of Petrarch (1304–1374) and then in those of Coluccio Salutati (1331–1406). Humanism became highly influential by the early fifteenth century. Humanists wanted to reform the Latin language by returning to the Latin usage of classical antiquity, as exemplified in the writings of Cicero (106 BCE–43 BCE), and by expunging what they considered to be crude medieval corruptions. Humanists also turned from the scholastic interest in logic, philosophy, and theology to rhetoric, moral philosophy, and history. The humanists admired and investigated the ancient past. They searched for new texts and studied and reedited them. They also investigated ancient artifacts and ruins, searched for ancient sculptures, and collected ancient coins and medals. Many humanists earned their livelihoods by serving as secretaries to princes, popes, cardinals, and other elite men, using their well-honed Latin skills in the process. They created an intellectual and bookish world concerned with a variety of skilled practices and physical objects. Humanism initially grew up outside of the universities, but eventually, by the late fifteenth century, it began to influence the course of studies within them.[15]

The new culture of humanism had important implications for the artisanal crafts. Humanism emphasized practical life as opposed to scholastic logic, and it encouraged an interest in material goods and in

the decorative arts that were part of daily life. It is notable that one of the greatest humanists of the fifteenth century, Leon Battista Alberti, who was educated at a university and possessed highly developed Latin literary skills, also wrote about sculpture, painting, and architecture, and practiced painting and architecture. Some humanists like Alberti wrote on the practical and technical arts. Practitioners themselves also began to write books with increasing frequency about their own disciplines. Writings about various practices and artisanal crafts found a readership among patrons and others in the elite and learned classes as well as among other practitioners.[16] Although writings on technical arts and practices had occurred since antiquity, such writings expanded rapidly in the fifteenth and sixteenth centuries. This proliferation of writings made the values of artisanal culture more readily available to be used as components of methodologies for the investigation of nature.

This book is aimed at a nonspecialist readership, and it is hoped that it may be of some use to historians of science and technology as well. Chapter 1 treats the history of the idea of artisanal influence on the new sciences as that idea emerged in the 1920s and 1930s. Such notions developed for the most part (but not exclusively) within the context of Marxism and Marxist notions concerning capitalist development. A second important context was the Vienna Circle in the 1920s and 1930s and the logical empiricism or logical positivism with which it was associated. Edgar Zilsel (1891–1944) developed the "Zilsel thesis" of artisanal influence on the scientific revolution. Zilsel lived and worked in Vienna and took part in the meetings of the Vienna Circle before he emigrated to the United States in 1939, where he wrote his seminal articles. In another context, the Russian physicist Boris Hessen (1893–1936) read a famous paper relevant to the issue of artisanal influence in London in 1931 at the Second International Conference for the History of Science and Technology. Shortly thereafter, in Frankfurt, Germany, a controversy broke out over the origins of the scientific revolution, both sides of which invoked aspects of the artisanal world. The protagonists were Henryk Grossmann (1881–1950) and Franz Borkenau

(1900–1957), both at the Institute for Social Research, known as the Frankfurt School.

Chapter 1 also discusses the views of non-Marxist scholars who address, in one way or another, the issue of artisanal influence on the new sciences. One is the philologist Leonardo Olschki (1885–1962), who in the 1920s wrote a three-volume work on technical writings in the fifteenth and sixteenth centuries and their importance for Galileo. Another is the American sociologist Robert Merton (1910–2003). The chapter also treats opposition to the view of artisanal influence—a position that prevailed among Anglo-American historians of science after the Second World War. It concludes with a discussion of the reemergence of the issue in recent decades within frameworks quite different from the original Marxist one.

In the remaining three chapters I explore the issue of the influence of artisans on the new sciences in the two-hundred-year period from 1400 to 1600 on the basis of primary source materials and from my own point of view. As will become apparent in these chapters, in general I think that artisanal influence on the new sciences was significant, but I suggest that the dichotomous categories with which the issue traditionally has been discussed— artisan/scholar, handworker/theorist, practice/theory, experimental/mathematical, art/nature—represent distorting lenses. It was precisely the blurring of these traditionally separate categories that provided the modality for the influence of artisanal values on the new sciences. Some artisans took up pens and began to write books, while some learned men began to take up artisanal practices such as surveying and measurement. Further, the distinction between artifactual objects, that is objects made by humans, and natural objects came to be blurred—for example, the potter Bernard Palissy (ca 1510-1589) fabricated platters embedded with lizards.

Chapter 2, on "art" (i.e., artisanal crafts) and "nature," discusses the historical interaction between these two changing concepts. This chapter first centers on the Aristotelian view of art and nature. It then turns to the question of the role played by experience and experiment in medieval natural philosophy and in medieval alchemy. The degree to

which experiment and empirical manipulations (that is, art) could lead to an understanding of nature depended on the assumed relationship between art and nature. By the late fifteenth century, there was a growing interchangeability of the two categories, and a growing tendency to use machines and instruments to investigate and discuss natural phenomena such as power and motion.

Chapter 3 treats the Roman architect Vitruvius (fl. 40s–20s BCE) and the Vitruvian tradition as an important common ground on which practitioners and university-educated men came together to discuss substantive issues. Vitruvius's treatise, the *De architectura,* was the only architectural treatise to survive intact from the ancient world. Beginning in the fifteenth century, a rich tradition of architectural practices and writings, including commentaries on the *De architectura*, picked up and developed the Vitruvian dictum that architecture consists of both fabrication and reason. Workshop-trained practitioners as well as university-trained humanists contributed to this written tradition, as they examined buildings and artifacts with the ancient text and measuring rods in hand. I suggest that Vitruvianism served as a modality for empirical investigation of issues involving building construction, hydraulics, and machines. Problems in understanding the *De architectura* in view of extant ancient buildings or ruins led to significant communication between practitioners and the learned. The Vitruvian tradition became a "trading zone" in which substantive communication occurred between the two groups.

The final chapter focuses on other "trading zones"—arenas in which the unskilled learned and skilled practitioners exchanged substantive knowledge. In the late sixteenth century, numerous locales served this purpose. These included arsenals, mines, workshops, and cities. Such places became important sites for communication and exchange between men trained as artisans and those schooled in Latin learning. Men from these diverse backgrounds exchanged information concerning material production and problems in engineering, but also concerning the nature of materials and of natural phenomena—traditionally topics belonging to natural philosophy.

This book shows not necessarily a direct influence of particular artisans on specific individuals investigating the natural world, although such influence did occur. Rather, it shows that the categories of "art" and "nature" became less and less apropos as categories indicating separate entities as the two came closer together and even became interchangeable. At the same time, the categories "scholar" and "craftsman" as classifications of types of individuals became an oversimplification when in some arenas the two moved closer together, communicated, and adopted each other's practices. I suggest that empirical values, once held predominantly by artisan/practitioners, came to be generally adopted by the society at large, thereby making them readily available for use by investigators of the natural world. I further suggest that this development came about, at least in part, by the widespread development of "trading zones" in which the learned and the skilled communicated, exchanging substantive information. I suggest finally that this development cannot be attributed to artisan-trained individuals alone but rather came about through the interaction of artisanal and humanist culture.

Artisan/Practitioners offers an introduction to the history of science through new discussion of an influential thesis in the discipline. The "Zilsel thesis" argues that artisans, craftsmen, and other practitioners exerted an important influence on the development of empirical methodologies in the Scientific Revolution, the "new sciences" of the late sixteenth and seventeenth centuries.

Artisan/Practitioners reassesses this issue of artisanal influence, providing both a synthesis and a critical revision of the complex social and intellectual developments that underlay the development of the empirical sciences.

Pamela O. Long is an independent historian of premodern European history and the history of science and technology. She has received grants and fellowships from many institutions, including the American Academy in Rome, the John Simon Guggenheim Foundation, and the National Science Foundation. She was a co-director of the Michael of Rhodes Project. She is the author of *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* and co-editor of the Historical Perspectives on Technology, Society and Culture Series.

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