

## PART IV

### SCIENCE AND TECHNOLOGY

*Pamela O. Long, independent scholar, United States*

The rapid expansion of knowledge of the geographical world in Shakespeare's lifetime was matched by rapid development of expertise in both *scientia* (knowledge of the world) and *ars* (mechanical arts). Advances in astronomy, cosmology, and natural history (the study of plants and animals, minerals, and fossils) accompanied, and in some cases inspired, revolutionary advances in cartography, navigation, textile manufacturing and clothing construction, mining and metallurgy, architecture and building construction, and military technology. Burgeoning artisan production and large-scale industries such as the wool cloth industry allowed banks, merchants, and city-states to engage in long-distance trade. This trade inspired rapid advances in mapmaking, navigational techniques, and shipbuilding. Voyages of exploration, conquest, and trade profoundly influenced, some would say fueled, natural history.

Shakespeare lived at a time when empirical practices of all kinds flourished. His contemporary Francis Bacon (1561–1626), Lord Chancellor of England until his dismissal in 1621, did more than anyone to fashion those practices into an empirical methodology with which to investigate the world. Bacon's writings became one influence among many others within a century of discourse and disputation, changing and contentious methodologies, new inventions and discoveries, and a series of innovations that taken together eventually came to represent the profound transformation concerning knowledge of the world that came to be called the Scientific Revolution. Shakespeare lived on the cusp of that new age.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Astronomy/cosmology/astrology
- The Copernican revolution
- Artisanal production
- Architecture and the building trades
- Navigation/exploration/trade
- Cartography
- Natural history
- Mining and metallurgy
- Alchemy
- Military technology and military culture
- Natural magic
- Shakespeare's transitional age

### 36. ASTRONOMY, ASTROLOGY, COSMOLOGY

*Raz D. Chen-Morris, Bar Ilan University, Israel*

Copernicus's rediscovery in 1548 that the earth revolves around the sun, and not vice versa, occasioned a rethinking of the cosmos. In particular, Copernicus's reasoning called into question the trustworthiness of sense experience. The problem was acute when it came to objects far away (the sun, planets, and stars) and those very small (atoms). The invention of the telescope and the microscope remedied these problems but had the effect of decentering the perceiver at the same time that it called into question the direct influence of planets and stars on human life.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- The limits of sense perception
- The shape of astronomical knowledge before Copernicus
- Astrology and its critics
- Reforming the heavens, 1543–1600
- Reforming astronomical observation with Kepler and Galileo

### 37. CARTOGRAPHY

*Valerie Traub, University of Michigan, United States*

During Shakespeare's lifetime, cartography underwent a revolution prompted by new geographical discoveries, new technologies for surveying the land, new mathematical formulas for rendering the curvature of the earth in two-dimensional space, and new commercial investments in disseminating maps through print. Characters in Shakespeare's plays use and refer to maps in ways that would have been unimaginable fifty years earlier. "Mapmindedness" included knowledge not only of the boundaries of one's nation and town but of the myriad life forms that inhabit the earth. To "know" a foreign land or to possess a cartographic awareness of one's own land was not only to conceptualize its geographical shape but also to identify its inhabitants, its flora and fauna, and its characteristic customs.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Maps and map metaphors in Shakespeare's plays
- Globes
- Atlases
- Charts as objects and metaphors
- English map production
- Maps as ethnography and natural history
- Selves and others
- *Cosmographia universalis*

### 38. BOTANY

*Leah Knight, Brock University, Canada*

In Shakespeare's lifetime, both continental Europe and England experienced a widespread reformation in botanical studies driven by humanist scholars expanding the approach to plants as *materia medica*, or medicinal materials, which dominated the medieval period, to include a more disinterested academic study of what came to be called *res herbaria*, all things herbal. Botanical knowledge was transmitted not only in printed encyclopedias but in other genres, including vernacular horticultural handbooks and husbandry manuals. Oral tradition and the increasing prevalence of printed herbal texts, together with a predominantly nonurban population, meant that considerably more informal botany was considered common knowledge than is the case today.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- The renaissance of botany
- Print herbals
- Botany in Shakespeare's England
- John Gerard's herbal and Shakespeare's poetry
- Shakespeare's botany

### 39. ZOOLOGY

*Andreas Höfele, University of Munich, Germany*

Renaissance England was a kingdom of animals. In the eyes of foreign travelers, one of the country's most remarkable features was its teeming pastures. In 1500, there were three times as many sheep as people, and the inhabitants of England ate conspicuously more meat than did people on the Continent. The information offered by Renaissance natural history is, in our terms, every bit as cultural as it is zoological, as concerned with an animal's symbolic, proverbial, heraldic, historical, mythological, and literary significance as with its anatomy and feeding habits.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- The zoology of everyday life
- Newly discovered animals
- The fate of mythical beasts in the new environment
- Thinking animals
- Post-Cartesian tensions
- Dehumanizing animals and animalizing humans
- The imaginative presence of animals in Shakespeare

### 40. TEXTILES AND CLOTHING CONSTRUCTION

*Maria Hayward, Southampton University, United Kingdom*

Clothing in Shakespeare's plays demonstrates three things: (1) how clothing can define a character and how that definition can change according to what the character is wearing; (2) how clothing can convey signals about a person's age, social status, wealth, taste, and state of mind; and (3) how clothing can provoke a range of responses in others, ranging from approval and admiration to ridicule and disapproval. The prominence of clothing onstage reflects major developments in the sixteenth century in types of textiles, in production techniques, and in clothing manufacture.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Types of textiles
- Uses of wool
- Uses of silk and linen
- Garments for men and women
- Acquisition and commissioning of clothing
- Tailors and tailoring
- Materials and trimmings

### 41. AGRICULTURE, FOOD DISTRIBUTION, COOKING

*Julian Yates, University of Delaware, United States*

The kitchen serves as a relay on the way to the table – that anthropologically charged site of social exchange where families, households, and nations assemble to eat, to talk, and to listen. Kitchen and stage share common ground as places of performance, places whose textual remains – cookbooks and dietaries, published play texts, and prompt books – express a desire on the part of cook and player, recipe and play text, to become something else.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Kitchens, tables, and talk
- Kitchen and stage as sites of practical knowledge
- Gesture sequences in the kitchen and onstage
- Comedies as cases of mistaken ingredients
- "Civil butchery," famine, and reckoning in history plays
- "Baked meats" in tragedy
- Taste testing in romance

### 42. METALLURGY

*Bert Hall, University of Toronto, Canada*

The natural world of physical objects was more resonant to early modern men and women than the same world of "dead matter" is to their modern counterparts. Matter was imbued with moral and ontological properties that we do not attribute to "mere objects" today. Metals provide a prime example. Metals themselves were thought to gestate in the earth, rather like fetuses in utero, after having been conceived in a union between passive matter and an active principle. In Shakespeare's day, astrology was essentially a branch of physics, and stellar influences were considered part of what shaped the world of nature.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Metal technologies in the sixteenth century
- Metal casting and metal founding
- Steelmaking
- “Mettle”/“metal” in Early Modern English
- Metal objects: gold, silver, steel, iron, copper, brass and bronze, lead, metal foils, and mirrors

### 43. ALCHEMY

*Katherine Eggert, University of Colorado, United States*

Alchemy in Shakespeare’s time was not a unified or orderly discipline or practice. Rather, it was an assemblage of theories and practices, many of them contradicting one another, that had developed over the previous millennium and that continued to see change and innovation throughout the sixteenth and seventeenth centuries. Easily and frequently derided as hokum from the moment it arrived in Europe in the early Middle Ages, alchemy nevertheless remained compelling because it promised what other, more legitimate Western philosophies of nature could not: not only an analysis of what the world was made of but also a means to purify that world into something finer, better, more valuable.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Classical and Arabic alchemy
- Medieval and early modern alchemy
- Skepticism and deception
- Shakespeare’s alchemy
- Alchemical reproduction in *Love’s Labour’s Lost*
- Alchemy and failed love in *Othello*
- Alchemy and imagination in Shakespeare
- Alchemy in *The Tempest*
- Alchemy and Shakespeare’s theater

### 44. MILITARY TECHNOLOGIES

*Patricia Cahill, Emory University, United States*

Gunpowder weapons, which had come to Europe in the first half of the fourteenth century, became essential to English warfare in the sixteenth century, and the manufacture and provision of ordnance (cannon, guns, powder, and shot) became a central preoccupation of the government. Numerous innovations in the design of both large and small artillery changed the tactics of pitched battles and siege warfare, and a host of new mathematical instruments helped soldiers set their weapons in place and calculate the range and distance of their shot. Geometry governed military architecture and fortifications, as well as new forms of manual drill and battle array in which soldiers were deployed within squares, rectangles, and other geometric patterns.

#### TOPICS COVERED IN THIS CHAPTER INCLUDE

- Shakespeare’s plays and contemporary technologies of war
- Battlefields in Shakespeare’s history plays
- Gunpowder weaponry
- Siegecraft and fortification