4 – THE SCIENTIFIC REVOLUTION AND THE ENLIGHTENMENT

OVERVIEW

During the sixteenth and seventeenth centuries, the knowledge of the world changed. The Scientific Revolution shook the foundations of the intellectual and theological traditions that had been formed during the Middle Ages. It would be a misrepresentation to classify the Scientific Revolution as either scientific or as a revolution. The science of the world didn't change, but rather the methodology of science, or the way man thought, underwent a transformation. In addition, the change took an extended period of time and was not revolutionary in the sense of the old being replaced immediately by the new; it was a gradual process of new ideas replacing old. Nevertheless, the Scientific Revolution permanently altered modern thought and the modern conception of the world around us.

The science of the Middle Ages, known then as natural philosophy, consisted of a mixture of Aristotelian, Ptolemaic, and Christian ideas about the world and universe. This natural philosophy, which supported the idea that God created a finite universe, became deeply rooted in and vigorously defended by Church orthodoxy. It was inconceivable to medieval scientists that the natural world could be examined outside the realm of religion and theology. After all, the universe was God's creation; he designed the universe and everything in it, so the truth about the nature of the universe must be compatible with the Christian religion and traditions. However, many of the ideas of sixteenth- and seventeenth-century thinkers were not only incompatible with but also contrary to the traditional Church dogma and, therefore, were strongly opposed by the Church.

For centuries, the intellectuals and theologians of Europe embraced the Ptolemaic concept of a geocentric universe, a universe with earth at the center. The ever-changing earth was thought to be composed of four basic elements: earth, water, fire, and air. Surrounding the imperfect earth were ten perfect crystal spheres that orbited the earth in circular orbits. Beyond the tenth sphere was heaven. For many, this was a logical, if not comfortable, arrangement. The entire finite universe revolved around the earth. The universe had limits, and man knew what and where those limits were. Beyond the limits of the universe was heaven, where God kept order in the universe. Is it any wonder that when these concepts were challenged, the Church reacted as if its very foundation was being attacked?

The Scientific Revolution instilled in European thinkers a new sense of self-confidence and self-reliance. This era of confidence in the human mind and faith in reason was known as the Enlightenment. Inspired by such intellectuals as Newton and Locke, Enlightenment thinkers used rational thinking and focused on such issues as moral improvement, economic growth, and political reform. This new breed of intellectuals believed that if reason could be applied to the laws of nature, then reason could also be applied to the laws of society. Enlightenment thinkers were optimistic about the possibility of changing the human condition.

The most famous and influential figures of the Enlightenment were the philosophes. These writers and thinkers sought the reform of government and society, and they made their thoughts known through the use of print. The *philosophes* thrived in the print culture of Europe, and they produced numerous books, pamphlets, and periodicals. During the era of the philosophes, the number of secular books increased tremendously, reflecting the idea of the Enlightenment that man did not need religion to find truth. Prose and poetry began to be considered of equal value, and the novel came into its own as a genre. The most famous of the philosophes were Voltaire, Montesquieu, Diderot, Rousseau, Hume, Smith, and Kant.

THE SCIENTIFIC REVOLUTION

At the dawn of the Scientific Revolution, the accepted ideas about the universe were still based upon those of Aristotle and Ptolemy. These medieval ideas were accepted because they easily supported what could be seen with the naked eye and because they were compatible with Christian doctrine. However, medieval universities and Renaissance thought helped create a group of intellectuals who were not afraid to think for themselves, even if that thought diverged from traditional thinkers. Furthermore, Europeans were beginning to explore lands further and further away from home, and they needed more advanced navigational methods and instruments. This, combined with a new way of thinking, spurred the movement of the Scientific Revolution.

One of the first truly revolutionary minds of the Scientific Revolution was Nicolaus Copernicus (1473-1543). Copernicus spent much of his early life studying church law and astronomy. It was during his study of astronomy that he became fascinated by the heliocentric universe, an ancient Greek idea that placed the sun at the center of the universe. This idea, of

course, contradicted contemporary scientific thought and challenged hundreds of years of traditional thought. Although he came to believe in a heliocentric rather than geocentric universe, Copernicus did not publish his work for fear of ostracism and ridicule. Rather, his work was published posthumously. The implications of the theories of Copernicus were immense. His theory implied that the universe was actually unimaginable in size, contrary to the traditional idea of a finite universe and that the earth was no longer the center of the universe. This greatly reduced the importance of earth in the grand scheme of the universe. Religious leaders across Europe, including both Calvin and Luther, criticized Copernicus for his ideas, which, according to them, directly contradicted the teachings of the Bible. The Catholic Church reacted a little slower but finally declared his work false in 1616.

Copernicus paved the way for other thinkers such as Tycho Brahe (1546-1630). This Danish scientist spent twenty long years observing the stars and collecting data. His lack of mathematical genius prevented him from using the data to develop theories and laws. Brahe's assistant, however, possessed the mathematical ability necessary to formulate scientific laws based upon the mountains of Brahe's research data. Johannes Kepler (1571-1630) used Brahe's work and findings to develop three very important natural laws. First, he said the orbits of the planets were elliptical and not circular. Second, Kepler said the planets move at different speeds in their orbits. Third, he said the time it takes for a planet to complete its orbit of the sun is relative to its distance from the sun. These three laws smashed the Aristotelian and Ptolemaic concepts of the universe to which Europe had clung for centuries, and he proved these laws mathematically.

Galileo Galilei (1564-1642) continued the break with tradition in his findings as well. A genius who became a math professor at age 25, Galileo used observation instead of speculation as he developed his theories. Among other things, Galileo worked with laws of motion and discovered Jupiter's moons. He destroyed the idea that the planets were mere crystal spheres and proved that the heavenly bodies were not always as they appeared to the naked eye. After the publication of his *Dialogue on the Two Chief Systems of the World* (1632), Galileo was arrested, tried for heresy, and imprisoned. This episode occurred only a few years after the pope had instructed Galileo that he could continue to write about the possible systems of the world that might exist, as long as he did not say in his writings which of those actually did exist. Galileo's trial has come to represent the conflict between science and religion both during and after the Scientific Revolution.

The greatest achievement of the Scientific Revolution was the synthesis of Copernicus, Kepler, and Galileo into a single system of thought. Sir Isaac Newton (1642-1727) developed a system of mathematical laws known as universal gravitation. Based on mathematics, Newton determined that every body in the universe is attracted to every other body in the universe in a mathematical relationship. He also asserted that the attraction of these bodies is based upon the amount of matter of the bodies and the distance between them.

Making of the Modern Scientific Method

The Scientific Revolution changed not only the knowledge of the times but also the methodology of obtaining knowledge. The two men most responsible for the development of the methodology were Francis Bacon (15611626) and Rene Descartes (1596-1650). Although Bacon and Descartes contrasted each other concerning methods of acquiring knowledge, the combination of their ideas results in the modern scientific method. Bacon, an English writer, championed a new experimental method of acquiring knowledge. He rejected the Aristotelian idea of speculative reasoning and advocated the inductive method. He believed that it was important to observe something in order to determine its nature and to learn more about it. Bacon's method is of ten referred to as *empiricism*. Descartes, a French mathematician who developed analytic geometry, advocated deductive reasoning. Descartes had great faith in the ability of the human mind. Therefore, Descartes method was to doubt everything, then use logic and reason to deduce the nature of things and the scientific laws that govern those things. Descartes reduced all substances to matter and mind, or the physical and the spiritual, which is a concept known as *Cartesian dualism*. The modern scientific method is a combination of the thinking of Bacon and Descartes. The scientific method employs both observation and logical thinking in the development of scientific theories and laws.

THE ENLIGHTENMENT

The Scientific Revolution changed the way Europeans thought, and this new trend in intellectual activity was known as the *Enlightenment*. The contemporaries of the age believed they were experiencing a new, enlightened period of reason and science. Although the Enlightenment occurred largely in the eighteenth century, its roots lay in the time period between Sir Isaac Newton and Louis XIV of France. The writers of the Enlightenment were greatly influenced by the unanswered questions of religious and scientific certainty and uncertainty that were brought to light during the Scientific Revolution. Because of the impact of the Scientific Revolution on the power of the human mind, the Enlightenment became a profoundly secular

movement that demonstrated man's independence from religion. In general, the Enlightenment affected the middle class and aristocracy of Europe and played almost no part at all in the lives of the lower classes.

The thinkers of the Enlightenment were heavily influenced by such thinkers as Newton and John Locke (1632-1704), both Englishmen, bur, for a few reasons, the Enlightenment reached its pinnacle in France. First, the international language of the educated elite in Europe was French. Second, although French thinkers and writers were sometimes jailed or forced to flee the country, they were never executed for their statements. Consequently, the French thinkers never faced insurmountable odds like some thinkers and writers in Central and Eastern Europe.

The Age of Enlightenment brought with it three main ideas that were manifest in the writings of the times. First, Enlightenment thinkers believed that the methods of natural science, which were developed during the Scientific Revolution, were applicable to all aspects of life. Second, they believed the scientific method was capable of discovering the laws of human society. Third, and perhaps most importantly, the Enlightenment thinkers believed in the possibility of both societal and individual progress and improvement for humans. In other words, the thinkers of the Enlightenment believed in the power of reason and in the power of the human mind to discover the laws that govern man and society. They also believed that the application of these laws to society could improve both man and society. Overall, the Enlightenment was a time of optimism.

Although some of the important intellectuals of the Enlightenment were the skeptics, such as Pierre Bayle (1647-1706), the most important and most influential of all Enlightenment thinkers were the *pbilosophes*. The *pbilosophes* claimed that they were bringing knowledge to Europe. They believed that they were shedding light on the dark, uneducated continent. The *pbilosophes* sought to educate the public, or educated middle class. They saw no need to educate the people, or the commoners of Europe, who the philosophes regarded as ignorant and deeply affected by superstition.

Because governments usually did not allow individuals to speak out directly against the government or against the established Church, many philosophes found clever ways to spread their ideas. Some of the philosophes produced their work in the form of books, encyclopedias, or pamphlets that were full of satire. By writing in this cryptic manner, the writers prevented their writings from being burned or banned. One such writer was the Baron de Montesquieu (1689-1755), who wrote The Persian Letters (1721), a satirical look at the customs and practices of Europe. Another *pbilosophe* who employed such methods was Voltaire (1694-1778). Voltaire criticized the established Church and other things in his satirical work *Candide* (I 759). The volumes of work produced by the philosophes increased both the demand for and sales of books in Europe. In addition, Europe saw a slight increase in literacy during this period, probably as a result of the increased interest in reading. The illegal book trade also prospered during this period.

Another step that was taken to prevent government interference in intellectual issues was the use of salons. Elite women began to organize and host salons in their homes. *Salons* were meetings of *pbilosophes* and other educated elites who gathered to discuss philosophy, politics, and current events. The *salons* allowed the free discussion of ideas and the uninhibited expression of public opinion. The women who hosted these salons began to rise in prominence, especially in France. The elite women hosting *salons* influenced not only intellectual trends but artistic trends as well. Through their political work, they began to influence a new artistic style known as rococo. The popular *rococo* style was characterized by delicacy and ornamentation and was reflected in the style of the drawing rooms where the salons were held.

The later Enlightenment saw the exaggeration of original Enlightenment ideas. These exaggerations were manifest in the inflexible and often dogmatic systems of thought, which of ten went far beyond traditional Enlightenment thought. Baron Paul d'Holbach (1723-1789) exemplified the later Enlightenment thinkers through his aggressive atheistic beliefs. This inflexibility and rigidity caused many Enlightenment thinkers to turn their backs on these new stubborn intellectuals. Ultimately, this disagreement in ideology caused a division between the traditional Enlightenment thinkers and those of the later Enlightenment.

EFFECTS OF THE ENLIGHTENMENT

The Enlightenment thinkers believed that an educated monarch would be ideal, supposing that he would make better laws and decisions concerning his or her subjects. Several central and eastern European rulers such as Catherine the Great of Russia, Frederick the Great of Prussia, and Joseph II of Austria, were inspired by the Enlightenment thinkers and made conscious efforts to rule as enlightened monarchs.

Catherine the Great (1729-1796, empress 1762-1796) studied the writings of Voltaire, Bayle, and others. She worked to bring Western culture to Russia. She tried to make better laws. In other words, she wanted to introduce enlightened, more tolerant legislation, legislation of which the philosophes would approve. Therefore, she introduced reforms such as the

abolishment of torture; she even allowed limited religious toleration. Catherine never questioned whether or not she should rule absolutely- she just did-but she tried diligently to rule as an enlightened absolutist. Frederick the Great of Prussia (1712-1786, king 1740-1786) sought to institute humane policies for his kingdom. He allowed religious freedom and philosophical freedom. He advocated education by improving the schools in his kingdom. He simplified his laws and pm in place hardworking, honest members of the judiciary. Frederick once expressed to Voltaire his desire to enlighten his people. Joseph II of Austria (1741-1790, emperor 1780-1790) acted as an enlightened absolutist by extending toleration to Protestants and Jews and by abolishing serfdom.

MAJOR PLAYERS

Thomas Hobbes (1588-1679) – Hobbes, an English philosopher, met with Galileo and Descartes and was affected by their philosophies. The English Revolution deeply disturbed Hobbes and played a major role in the development of his idea that man was totally depraved. He believed that, because of man's depravity, an absolute, sovereign ruler was necessary to keep man under control. His absolutist views, however, were not based on the concept of the divine right of kings. He outlined his views on sovereignty in his classic work *Leviathan* (1651).

Blaise Pascal (1623-1662) – Pascal was a brilliant French scientist and mathematician who invented a mechanical calculator. Pascal's objective was to unite Christianity and science by proving that Christianity was not contrary to reason. Pascal said, "This is what constitutes faith: God experienced by the heart, not by the reason." Pascal's greatest work, published posthumously, is known as *Thoughts on Religion and Other Subjects*, or *Pensées*.

Baruch Spinoza (1632-1677) – Educated in the Jewish tradition, the Dutchman Baruch Spinoza was later alienated from Judaism because of his study of Descartes and Hobbes. Spinoza advocated pantheism, the idea that everything that exists is God and God is the substance of things. He followed Descartes' ideas about knowledge and the separation of mind and matter. He rejected the ideas of both providence and free will. Spinoza's greatest work was *Ethics Demonstrated in the Geometrical Manner*.

John Locke (1632-1704) – Locke, an English philosopher, played a major role in the development of modern western thought and government. Locke emphasized the role of empiricism rather than the Cartesian concept of innate ideas. In his famous work *Essay on Human Understanding* (1690), Locke argued that the human mind was a *tabula rasa*, or blank slate, at birth. According to Locke, experiences formed and shaped man's knowledge. Locke also argued that man was born good, not depraved, and equal. In his *Two Treatises of Government* (1 690), Locke attacked the divine right of kings, thereby contradicting the ideas of Hobbes. Locke said that the sovereignty of the state lay within the people and that the people possessed unalienable rights, called *natural rights*. Locke went even further by saying that the people have a right, if not an obligation, to rebel or revolt if the government were to infringe upon those rights. In addition, Locke advocated freedom of religion and separation of church and state. Locke had a profound influence on the development of the United States Constitution and the government of the United States. The thinkers of the Enlightenment regarded Locke, along with Newton, as one of the greatest European minds of all time.

Pierre Bayle (1647-1706) – Pierre Bayle, a French philosopher and skeptic, led the way for skepticism. Born a Protestant, Bayle converted to Catholicism and then back to Protestantism. His works, the most famous of which was *Historical and Critical Dictionary*, attacked superstition, religious dogma, and religious tradition. He also attacked traditional religious heroes like David of the Bible. Bayle believed that Christianity and morality did not necessarily go hand in hand. Bayle also argued against religious intolerance, probably in reaction to Louis XIV.

Bernard de Fontenelle (1657-1757) – Fontenelle was a French scholar who knew a great deal about science. For several years, he served as secretary for the French Royal Academy of Science. Fontenelle is best remembered for his book *Plurality of Worlds*. Written as a conversation between a man and woman sitting under the night sky, *Plurality* made the world of science accessible to non-scientists by integrating science with literature. Fontenelle downplayed the importance of religion and the Church, thus contributing to the skepticism of the seventeenth and eighteenth centuries.

Montesquieu (1689-1755) – Montesquieu's full name was Charles Louis de Secondat, Baron de la Brede et de Montesquieu. This French writer produced some of the most important works of the Enlightenment. His early work *Persian Letters* (1721) satirized and criticized French politics and social practices. It was written as a collection of letters between two aristocratic Persians who had traveled to Europe and discussed what they had seen. Montesquieu chose this manner of writing to avoid persecution for his statements. Montesquieu also dealt with the philosophy of history in his *Thoughts on the Causes of the Greatness and Downfall of the Romans* (1734). In 1748, he produced his most famous writings, *The Spirit of Laws*. In this book, Montesquieu examined the republic, monarchy, and despotism. He

contended that a country's geography and general conditions helped determine what type of government evolved there. He advocated a balance of power within the government to protect and preserve individual freedoms. He also spoke out against slavery because it was a violation of a person's individual freedom and of natural law.

Voltaire (1694-1778) – Francois Marie Arouet assumed the name Voltaire for his writings. Voltaire may have been the greatest of all the philosophes. Much of Voltaire's life and career were shaped by a journey he made to England. After that journey, Voltaire forever preferred England to his native France. Voltaire admired England's religious toleration and respect for Sir Isaac Newton. A1though Voltaire received a Jesuit education, he despised the Catholic Church. In fact, he disapproved of all organized religion. Voltaire was a deist who saw organized religion as oppressive. He voiced this opinion in the wake of the Lisbon earthquake in 1755 by publishing his grearest work, *Candide*, in 1759. In *Candide*, Voltaire tried to show the evils of the Church and of organized religion. Through this work, he contended that individuals should seek peace within themselves instead of in a set of beliefs or doctrines. In 1763, Voltaire published his *Treatise on Toleration*, in which he eloquently pleaded for religious toleration. He believed in freedom of thought and respect for all, and he used his writings to champion these ideals.

David Hume (1711-1776) – David Hume was a Scottish historian and philosopher who advocated skepticism and empiricism. He said that careful observation of human experiences would lead to the knowledge of human nature. He also argued that since man's ideas are based on his experiences, reason cannot answer questions that can't be answered by empiricism. Hume also argued against the existence of miracles. One of his most famous works was *Philosophical Essays Concerning Human Understanding* (1748).

Jean-Jacques Rousseau (1712-1778) – The French philosopher Jean-Jacques Rousseau began his scholarly career working alongside Diderot on the *Encyclopedie*. Rousseau developed the idea that man in the state of nature, or as primitive man, was morally superior to modern civilized man. Rousseau argued that modern man had become corrupt by art, science, and modern institutions and innovations. With this idea, he alienated himself from some of the *philosophes*. In 1762, Rousseau published *The Social Contract* in which he said that man agreed to be ruled by creating a sort of social contract between the government and the governed. Rousseau said that in this relationship, the individual should submit to the general will, or the will of the community, in order to be free. Rousseau downplayed individualism and said that the individual was part of the greater community.

In 1762 Rousseau also published *Émile*, another book that created a stir among his contemporaries. In *Émile*, Rousseau told the story of the education of a young boy named Émile. Rousseau advocated the development of children's emotions instead of the development of children's reason and logical thinking. Rousseau also suggested that children be treated like children and not like adults. Because of his view of emotions over reason, Rousseau found himself at odds with Voltaire.

Denis Diderot (1713-1 784) – Diderot was a French writer of novels, essays, plays, and criticisms. H is most famous work, though, was the *Encyclopedie*. He was asked to work on a French translation of the English *Cyclopaedia*. He, along with Jean le Rond d'Alembert, overhauled the work and produced a thirty-five volume *Encyclopedie*. Diderot enlisted the help of some the greatest contemporary writers like Voltaire and Montesquieu. The *Encyclopedie* was an attempt to organize information in a rational and scientific fashion. Diderot hoped these volumes of information would change the way people thought. The *Encyclopedie* drew attention from far and wide. Several of his volumes were banned across Europe and included in the *Index of Prohibited Books*. Catherine the Great of Russia, on the other hand, financed some of the work by Diderot. Even Thomas Jefferson and Ben Franklin had copies of the *Encyclopedie*.

Adam Smith (1723-1790) – Adam Smith, once a professor in Glasgow, emerged as the most important and influential economists of the Enlightenment. The Scottish Smith met with a group of economists called *physiocrats* on the Continent and was heavily influenced by their ideas. He adopted much of their ideology that maintains that economics is based on natural law, wealth, and order. In 1776, Smith produced *Inquiry into the Nature and Causes of the Wealth of Nations* (usually referred to as *Wealth of Nations*). In this book, he advocated the abolition of mercantilism and all government interference in economics. Smith preferred a *laissez-faire* economic policy, one in which the government takes a hands-off economic approach. Smith believed that individuals who were left alone to invest and spend on their own would act as if an invisible hand is leading them. This invisible hand would lead them, according to Smith, to act in the best interest of everyone. In *Wealth of Nations*, Smith created a classic economic text that is still used and studied by Economics students today.

Immanuel Kant (1724-1804) – The German philosopher Kant has been called the most influential modern philosopher. His two great works were *The*

Critique of Pure Reason (1781) and *The Critique of Practical Reason* (1788). He examined in these books the nature and basis of knowledge. One of Kant's most well-known concepts is that of the categorical imperative. This concept is that humans possess an innate morality, which compels a man to act in any given situation the way one would want others to act in that same situation. Kant used this imperative to support the existence of God. He realized this could nor be proved, but he still accepted it. He also accepted rationalism and reason. Kant's work lacer influenced Hegel and Marx.

Edward Gibbon (1737-1794) – Gibbon was the greatest English historian of the Enlightenment. In 1776, Gibbon began his voluminous work *The History of the Decline and Fall of the Roman Empire*. Although we have data that refutes some of his work, Gibbon's masterpiece remains a classic. The work illustrates Gibbon's skepticism of religion through his treatment of early Christianity as a natural phenomenon instead of as a religion of miracles and providence.