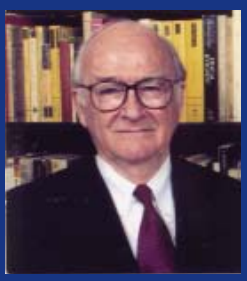
AMERICAN UNIVERSITY STUDIES

Forging The Methodology That Enlightened Modern Civilization

RICHARD SCHLAGEL

Forging the Methodology That Enlightened Modern Civilization presents a review of two millennia of human strivings to attain a more realistic understanding of the universe and humans' place in it. The earliest attempts were mythical accounts invoking miracles and intentional explanations involving spirits, angels, and gods. It was the ancient Greeks who first achieved a more rational understanding of the world as shown in their prescient theories of evolution, atomism, heliocentrism, and physical cosmologies.

Later developments include the supernatural worldview of the medieval period followed by the Arabic renewal of the Greek achievements by translating their manuscripts and emulating their research. This endeavor led to the scholastics of the Renaissance reviving and revising Aristotle' worldview and to the introduction of some of the crucial concepts of later classical science. The latter, inaugurated by Copernicus's defense of heliocentrism followed by the remarkable discoveries of Kepler, Gilbert, Harvey, and Galileo, culminated in Newton's universal laws, forces, cosmology, and optical theory that formed modern classical science. Newton's deterministic cosmology of absolute space and time persisted until the introduction of quantum mechanics and Einstein's relativity theories in the twentieth century. The present volume clearly establishes that there is an inevitable conflict between science and religion and why science is prevailing.



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Cover illustration by Edouard Riou (1870) of Galileo demonstrating his telescope in Venice in 1609.

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A good scientist should never be so arrogant as to be *certain* about anything. Never, that is, apart from on one point: that what we refer to as the modern scientific method is *non-negotiable* in its all-encompassing importance as a worldview. Many would argue it is the *only* worldview that a rational thinking person can have in explaining how and why the world is the way it is.

Jim Al-Khalili
Pathfinders: The Golden Age of Arabic Science

Table of Contents

Introduction

The influence of science and technology is so prevalent in western societies today that it is easy to take for granted how much the standards of living, advancements of knowledge, medical developments, educational opportunities, liberating and equitable social and political institutions, along with world travel and nearly instantaneous communication and dissemination of information are owed to these achievements. Yet visiting those societies that have not yet acquired the benefits of western science and culture, as in most countries of Africa and some in the Middle East and South America, and to a lesser degree now in regions of China and India, offers a striking reminder of the difference.

Moreover, those who disparage this progress owing to the greater devastation during the First and Second World Wars due to the advances in technology that produced gas warfare, more lethal artillery, horrendous bombing raids, V-1 and V-2 rockets, and the incredible radiational incineration spewed by the atomic bomb, overlook that it was not the advanced weaponry that was at fault, but fanatics like Hitler who incited the wars. While Einstein's formula $E = mc^2$ and Lise Meitner's theory of nuclear fission, along with the effort of the most brilliant team of theoretical physicists and engineers ever assembled, led to the success of the Manhattan Project and the detonation of two atomic bombs, it was the heads of state who decided how it would be used. The realization that Werner Heisenberg was directing nuclear research in Germany with the intention of creating an atomic

bomb led to Niels Bohr informing Churchill and Leó Szilárd and Einstein advising President Roosevelt that their countries must create the weapon before Hitler, otherwise the Third Reich would win the war and dominate the world.

Furthermore, the decision to drop the bomb on Hiroshima and then on Nagasaki was not made by the scientists that created the bomb, such as Enrico Fermi, James Franck, and J. Robert Oppenheimer who were opposed to using it, but by President Truman. It was his decision that dropping the bombs was necessary to force the Japanese to surrender without having to invade Japan that could have resulted in many more casualties. Later, during the cold war between the Americans and the Russians, long range warfare was made possible by the development of intercontinental nuclear warheads or missiles leading to the Cuban missile crisis that was resolved owing to the threat of "mutual destruction."

Again, however, it was the heads of state and generals who were responsible for making the decisions and providing the financing to create the advanced military technology to serve their national interests. Similar arguments can be offered to refute the charges that technological developments also were responsible for the dreadful initial exploitation of unskilled workers during the industrial revolution, creation of modern urban ghettos, environmental degradation, and climate change, but that would be like blaming the Christian religion for the current pedophiliac scandal of the Roman Catholic Church or Islam for the worldwide Jihads, rather than the clerics and terrorists responsible for these deviant acts.

Instead of blaming the institutions for these depravities, they should be attributed to the pervasive weaknesses of human nature that produced them: irrationality, avarice, egocentrism, aggression, sadism, and the lust for and fixation on power. It no longer being credible to ascribe these tragic human failings to original sin, they now can be attributed to our evolutionary heritage driven by competitive natural selection or "survival of the fittest" as encoded in our genes. As with social conventions, political institutions, legal structures, economic systems, and personal relations, the effective utilization of scientific research and technology can only be as humane or enlightened as their use by human beings.

Another reason there seems to be such an unappreciative attitude toward contemporary science is that unlike the Enlightenment when savants were extolling the accomplishments and promise of modern science in contrast to the stifling feudal system it was replacing, most people today ignore the horrific conditions that prevailed throughout history: the poverty, disease, ignorance, illiteracy, and natural disasters, along with the universal exploitation and repression by the prevalent tyrants or autocrats.

A further cause of the aversion to science is that its resultant worldview has discredited the supernatural framework of the world's religion's that provided so much spiritual comfort, support, and moral direction in the past, as it still does in

the present. Dislodging human beings from the center of the universe and explaining their origin as due to natural conditions rather than a special creation, replacing miracles by scientific explanations and eliminating the credibility of such Christian doctrines as the virginity of Mary and the virgin birth of Jesus (who would have lacked the male chromosomes for a normal birth), and understanding the molecular impossibility of the transubstantiation of the Eucharist has eroded the belief in Christianity for those who comprehend the significance of these developments.

Moreover, having discovered that mystical experiences, feelings of blissfulness, and hearing divine commands are due to localized neurophysiological processes and excluding any transcendent meaning to human existence given the distressing state of the universe and human existence as we know it, science is looked upon as the destroyer of cherished, consoling beliefs, rather than as the liberator from ignorance and superstition and ameliorator of the human condition.

It is the hope of the author that when confronted by the remarkable discoveries, theoretical explanations, cognitive transformations, and technological advances that brought about these developments the reader will be better able to accept scientific inquiry as the intellectual and social liberator that it has been, as well as the most effective means for improving the dreadful living conditions of the past.

But my focus will be on how this understanding has been acquired, rather than on the changes that it has brought about. This is because the former conforms more to my research and publishing endeavors and also because the other aspect has been excellently described by Timothy Ferris in his recent book, *The Science of Liberty*,[1] that I commend to anyone interested in knowing what a difference scientific inquiry has made to the advent of modern civilization.

CHAPTER ONE

Our Greek Heritage Including Plotinus

The emergence of an empirical-rationalistic orientation eventually dispelling the previous mythopoetic rendering of the world by a more realistic explanation was initiated by the ancient Greeks. Their legacy from the seventh century BC first includes the Milesians—Thales, Anaximander, and Anaximines—whose cosmological explanations of the universe, as arising respectively from Water, the Unbounded, and an Air-Substrate, were more naturalistic than a divine creation, as was Anaximander's account of land animals evolving from aquatic creatures. There followed Anaxagoras' principle that since "being cannot come from not-being nor perish" what exists must be "ultimate and indestructible;" Empedocles' doctrine of the four elements, "fire, air, earth, and water;" and Leucippus and Democrates' prescient atomic theory. Philolaus' attribution of "an oblique circular motion" to the earth around a central fire, along with Heraclides of Pontus' addition of a rotational motion from west to east (with the stars fixed) to account for the apparent rising and setting of the sun and determination that Mercury and Venus revolve around the sun, led to Aristarchus' heliocentric theory. Yet it was Ptolemy's geocentric astronomical system that prevailed until Copernicus adopted heliocentrism owing to its greater harmony and mathematical simplicity, citing the Pythagoreans as his predecessors.

Along with these developments there was Hippocrates' famous medical school at Cos and the physiological investigations of Herophilus and Erasistratus, as well as the impressive mathematical discoveries of the Greeks beginning with the

Pythagoreans who, according to Aristotle, "regarded numbers as the elements of all things, and the whole heaven as a musical and numerical scale;" Hippocrates of Chios whose work compiling the *Elements of Geometry* preceded Euclid; Eudoxus of Cnidus who made the incredibly accurate determination of the solar year to be 365 days and 5 hours and who originated the view that the celestial bodies revolve on a series of concentric spheres with the earth in the center; and Archytas of Tarentum who maintained that the universe was infinite and eternal and solved the famous problem of "the duplication of the cube." These were remarkable achievements especially when contrasted with the mythical or mystical accounts of the various religions, such as the Old Testament Genesis depiction.

In addition, there were the tremendous contributions of Plato and Aristotle, the formers' marvelous dialogues and profoundly influential metaphysical system composed of three eternal components: the Receptacle or spatial-temporal locus of created entities in the empirical world; the transcendent existence of the Realm of Forms or ideal archetypes culminating in the Good that were the referents of all true knowledge and moral principles, as well as the model of creation imperfectly exemplified in the Receptacle; and the Demiurge whose function it was to impose as much as possible the Ideal Forms on the imperfect, intractable contents of the Receptacle leading Plato to refer to any account of the physical world as "a likely story." In addition to its influence on mathematicians because of its being the method of achieving knowledge of the Realm of Forms, it also inspired Plotinus' Neoplatonic conception of Divine Emanations.

Then there was the tremendous influence of his pupil Aristotle who, after studying in Plato's Academy for twenty years, produced the extensive treatises on physics, astronomy, metaphysics, logic, categories, the soul, dreams, biology, generation and history of animals, ethics, and politics that tended to dominated Western thought, as interpreted by the scholastics, from the 13th to the 17th centuries. Often regarded as the "Authority" of all knowledge during that period, he could justly be considered the most comprehensive thinker of all time.

With his death in 322 BC there followed the Hellenistic Period during which the center of learning shifted from the renown Academy of Plato and Aristotle's Lyceum in Athens to the famous Library and Museum established by the Greek Ptolemies in Alexandria that was founded by Aristotle's pupil Alexander the Great in 332 BC. As Charles Singer states:

> From 300 B.C. to A.D. 200 most eminent men of science were teachers at Alexandria. A few, notably Archimedes and Galen, were less intimately linked with the Egyptian metropolis. Yet even they were pupils and corresponded with Alexandrian teachers. Greek science from about 300 BC onward is thus not inadequately described as "Alexandrian Science."[2]

Among its outstanding early scholars were Eratosthenes the librarian who devised an ingenious method for measuring the circumference of the earth, invented the famous "Sieve" for investigating prime numbers and also measured the obliquity of the ecliptic; Euclid, whose early schooling had been in Plato's Academy, was among the first to be attracted to Alexandria where he wrote his *Elements of Geometry*, parts of which are included in geometry books today and which has been described as "the greatest textbook ever written;" Apollonius of Perge, who is reported to have "spent a very long time with the pupils of Euclid at Alexandria," is famous for his investigation of conic sections and introduction of the terms 'ellipse,' 'parabola,' and 'hyperbola' to designate the various curves produced by three different angular sections of the cone which were instrumental in Kepler's discovery of his three laws of planetary motion; Hipparchus who, owing to his numerous astronomical investigations, detected the precession of the equinoxes and introduced "epicycles" and "eccentrics" to explain the observed variations in size and brightness of the planets that were inconsistent with Eudoxus' circular orbits; Strabo the geographer and cartographer; Galen whose accurate anatomical and physiological studies based on dissections of dead and living animals enabled him to construct an ingenious physiological system remarkably accurate for the period; Hero of Alexandria whose playful contrivances and clever practical instruments enhanced his investigations in optics and dioptrics and whose *Mechanics* shows "understanding of the cogwheel, of rack and pinion, of multiple pulleys, of transmission of force from a rotating screw to an axis at right angles to it, and to the combination of all these devices with levers" (p. 86), and Ptolemy who created important astronomical instruments and whose *Almagest* employing the epicycles and eccentrics of Hipparchus to explain the (illusory) retrograde motions of the superior planets and the variations in brightness and distance of each of the planets replaced all previous astronomical systems until Copernicus's *De Revolutionibus orbium coelestium* published in 1543.

Studying in Sicily rather than Athens or Alexandria but corresponding with the scholars at Alexandria, Archimedes (287-212 BC), renown for his outstanding contributions to mathematics and physics, was also famous for his ingenious technological instruments, such as levers and pulleys, used in the defense of Syracuse during the siege of the Romans. He invented the mechanical screw to raise water and experimentally proved the principle of specific gravity, evidence that the Greeks were not remiss in performing rudimentary experiments to develop and test their theories, as was true of Galen, Hero, and even Aristotle whose investigations dissecting insects and animals were highly praised by Darwin. Thus they are rightly credited with initiating research in most branches of science, including the first attempts to explain the origin of the universe naturalistically, pursuing

empirical medical investigations, introducing such formalisms as deductive logic, geometry, and the methods of exhaustion and integration that were precursors of calculus, inventing numerous technological instruments and devices that constituted the foundations and inspiration for the later developments of modern classical science.

Before leaving this discussion of the marvelous mathematical and scientific legacy of the ancient Greeks, some mention should be made of Plotinus whose philosophy of Neoplatonism has been described as "the culmination of all Greek philosophy"[3] (although Clark's claim is hardly justified since his philosophy is completely devoid of any scientific content). He lived from 205-270 AD and though he made no contributions to mathematics or science, his orientation being completely mystical, the considerable influence of his theory of emanation on some Muslim scientists and the scholastics justifies some description of his philosophy.

A native of Egypt but perhaps of Roman descent, at age twenty-eight he went to Alexandria where he became a disciple of Ammonius Saccas for ten years and then formed an association with Longinus and Origen who were among the greatest of the Greek Fathers of the early church. After a distinguished career in the service of several Emperors, at the age of forty he established a society of philosophers in Rome where he wrote his great work, the *Ennaeds,* and taught until his death. Owing to his weak eyesight it was Porphyry, one of his students, that he entrusted with the task of editing his manuscript and who wrote the first biography of him. Because Porphyry arranged the manuscript into six books with each book containing nine Tractates (treatises), it acquired the name *Ennaeds*, meaning nine treatises. As I wrote previously, "Porphyry published the *Enneads* at the beginning of the fourth century when Christianity was about to be proclaimed the official religion of the Empire by Constantine. Although Neoplatonism was a pagan philosophy, its devout mystical content made it congenial to the emerging Christian theology that was to dominate and transform philosophical inquiry for the next thousand years."[4]

According to Porphyry, Plotinus described four mystical visions that were the basis of his reinterpretation of Plato's tripartite philosophy as three superimposed domains called "*hypostases*," variously translated as the "One" or the "Supreme," the "Intelligible World" or the "Divine Mind," and the "World Soul" or the "Universal Soul." (p. 417) The last two hypostases, the "Intelligible World" and the "World Soul" are further divided, the former containing "Intelligible Beings" and the latter animals, disembodied souls and demons, along with the souls embedded in humans and plants.

His conception of the manner of creation as an "emanation," "overflowing," or "radiation," though influenced by Plato, is exceedingly original derived from his mystical visions. Beginning with the "One" which is beyond Being, each *hypostasis*