THE RELATIONSHIP BETWEEN SCIENTIFIC, TECHNICAL, AND MORAL KNOWLEDGE IN CLASSICAL ANTIQUITY

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Summary

This article seeks to show how, as early as classical antiquity, issues concerning technology were explored as part of a major philosophical discourse. Following on from myth, it was claimed that legitimate use could be made of nature for human purposes. From this perspective, the prestige and status of technology is based on the idea that, in the natural scheme of things, humans are inferior to other creatures, and hence need the help that technology can give, and that advances in civilization have always occurred in conjunction with technological inventions. In antiquity, the critique of technology was not rooted in the idea of protecting nature but in the aim of limiting the negative effects of technological development on society by demanding that humans' material needs be curbed.

1. Introduction

In ancient Greece, scientific knowledge, technical competence, and moral reflection did not develop simultaneously. Instead, they progressed independently of each other, at different times, and in different literary contexts. Although technical knowledge was formulated in writing only at a relatively late stage for a few fields of technology and, despite the absence of any actual philosophy or theory of technology in classical antiquity, numerous links exist between technology and technical action on the one hand and literary, historiographic, and philosophical works on the other. It is possible to identify several topics that played an important role in the ancient discourse on technology and that remain relevant to the current debate surrounding the relationship

between humans, technology, and nature: these topics include the evaluation and legitimation of technical action, the legitimacy of people's use of nature and, finally, the philosophical demand for a renunciation of the material goods that are not essential to human survival.

2. Technical, Moral, and Scientific Knowledge in Classical Antiquity

2.1. Technical Competence and Technical Knowledge

In archaic Greek society (eighth to sixth century B.C.E.), technical competence comprised orally transmitted empirical knowledge and manual trade and craft skills. By the late archaic period (sixth century B.C.E.), however, the construction of monumental structures—temples, bridges, aqueducts, and breakwaters—represented new and complex challenges for the tradesmen charged with their planning and execution. These tradesmen became known as "architects" (i.e. chief (*arkhi-*) builder (*tekton*)). Technical expertise was therefore no longer a question of experience and routine alone but also involved the ability to solve technical problems. Thus, for example, it was the architects' task to organize the transportation of the heavy stone blocks used in construction to the building site and to construct hoisting devices for raising the blocks to be used for architraves to the required height. Thanks to their technical expertise and achievements, architects developed a heightened self-awareness and began to write their own accounts of their activities or the construction of individual buildings. Construction technology achievements were considered worthy of record and were duly described in detail in ancient historical accounts and in the specialist technical literature. The use of mechanical instruments in trades and medicine prompted doctors and, at a later stage, philosophers, such as Archytas of Tarentum and Aristotle to try to describe these instruments—lever, roll, hoist, and wedge—in detail, and to explain their effects in terms of mathematical rules. Thus, in the fourth century B.C.E. a specialist literature emerged dealing with mechanics, which was recognized as a scientific discipline: the work of Heron of Alexandria (first century C.E.) represents one of the main achievements of this literature.

Agricultural work was also increasingly perceived as human technical action in the fifth/fourth century B.C.E. as people employed the muscle power of animals and appliances such as the plow to work the fields and relied on a detailed knowledge of cultivation methods. Hesiod summarized the technical knowledge of Greek farmers at an early stage in his didactic poem *Erga* (Works [and days], late eighth century B.C.E.). The tradition of specialist agricultural literature was founded by Xenophon who provided a detailed description of work on the land in his *Oeconomicus* (fourth century B.C.E.). Although Roman agricultural writers were mainly interested in the economically successful management of large estates, in addition to writing on questions of organization and the sale of agricultural products, they also recorded information about cultivation methods, fertilizer processes, and livestock-breeding practices. They also provided detailed descriptions of various appliances used in agriculture, such as wine presses, oil mills, and thresher carriages.

Vitrivius' writings on architecture (late first century B.C.E.) belong to the specialist technical literature of the early Roman Empire. An engineer himself, Vitruvius had a

profound interest in technical matters and inventions and provided detailed descriptions of various building materials, the construction of harbours and aqueducts, the hoisting devices used on building sites, and water bailers: the first detailed description of a water-mill was written by Vitruvius. The clear distinction between tools and mechanical devices can also be seen as a significant technological achievement.

Another area of technology in which the written recording of knowledge played a very important role was military technology and this involved, in particular, the construction of catapults and siege machines. The invention of the catapult around 400 B.C.E. can be seen as an important advance in the history of military technology. When it came to the construction of catapults, mathematicians and mechanical engineers were faced with the difficult problem of calculating the size of the individual components of the weapon in such a way that the missile had maximum reach and penetration. As a result, the construction of catapults became the object of a new specialist discipline that applied complicated mathematical processes to resolving structural problems.

Thus, the specialist technical literature of classical antiquity covered only a few areas and many of the manual trades were never described in specialist publications. This is true of all branches of metals processing, textile production, ceramics, and the manufacture of glass and glass vessels and also applies to certain areas of construction technology such as bridge and tunnel building. Furthermore, it can be confirmed that many of the descriptions of tools, devices, and technical processes in the ancient literature were not intended to provide detailed technical information for engineers but were intended to clarify or explain the philosophical or scientific position of the author in various discursive contexts. The presentation of individual inventions by Plinius, for example, was too brief and imprecise to enable the reconstruction of the objects in question. Furthermore, the lack of precise illustrations, which could have been provided given the quality of early modern woodcuts, copper engravings, and etchings, made communication between technicians difficult. As a result, in classical antiquity, technical knowledge was largely disseminated from one generation to the next through oral transmission and practical training.

2.2. Moral Knowledge

Moral reflection is found in Greek literature as early as Homer's epics in which the action of individual heroes is subject to detailed critical evaluation. In the *Iliad*, for example, the gods disapprove of the horrific desecration of Hector's corpse by Achilles. Hesiod's *Erga* warns of the necessity to heed the law of the gods and always act in accordance with standards of justice. The use of violence in human communities is condemned: according to Hesiod, humans and animals differ in that the strong overcome the weak in the animal world while humans are ruled by the law and its observance is monitored by Zeus. In the Greek tragedy of fifth century B.C.E., the ethical dilemma of the individual is presented in exemplary scenarios and several of the tragedies present arguments for or against a specific mode of action. While in tragedy ethical reflection remains integrated into the dramatic events, ethical problems were explored directly in the philosophical writings of the time. In Plato's work, the question of correct action is explored in particular in the context of the criticisms of rhetoric and sophism and in the framework of political theory. According to Plato, human action

should be based on the idea of the good and, hence, on what is right. Thus, Plato came to the conclusion that it would be better to suffer injustice than to perpetrate injustice, like a tyrant. In Aristotle's work, ethics became a separate philosophical discipline and subsequent schools of philosophy placed a great emphasis on questions of ethics within their philosophical system. Different philosophical directions remain indebted to the Socratic–Platonic philosophy and request the renunciation of all goods that are not essential to a nature-oriented life. The increase in needs and the associated efforts to increase individual wealth at the cost of others was decisively rejected by the Cynics and the Stoics. The Stoics, whose teachings were enthusiastically embraced by many members of the Roman ruling classes, supported an ethic involving the renunciation of the material achievements of civilization and also specifically criticized the luxurious lives of the wealthy upper strata of society. Without doubt, the primary aim of ancient ethics was to develop and justify rules for the social life of the people. Only a few texts exist in which the focus is on the relationship between people and their environment.

2.3. Scientific Knowledge

The emergence and unfolding of scientific thought that is dissociated from empirical knowledge is closely related to the development of medicine and philosophy: doctors reflected on medical methods and defined criteria for a scientific discipline (*tekhne/episteme*) as early as the fifth century B.C.E. Since Plato and Aristotle, philosophers have also expressed considerable interest in questions surrounding epistemology and logic, and mainly focused on the reliability of sensory perception, the distinction between true and false statements, and the foundation of precise knowledge. Aristotle, in particular, examined and systematically presented various topics from a philosophical perspective in his writings and in this way founded a series of specialized disciplines (i.e. logic, astronomy and cosmology, nature study (physics), zoology (*historia animalium*) as well as metaphysics, ethics and political theory, and finally rhetoric and aesthetics). Subsequent authors continued this research in new areas; for example, Theophrastos (fourth century B.C.E.) compiled detailed works on plants and thereby founded the science of botany. In the Hellenic and Roman periods, doctors strove to add to the medical knowledge collected in the *Corpus Hippocraticum*. Finally, the names Pythagoras, Thales, Eudoxos, and Eucleides (Euclid) are associated with major mathematical insights that are still considered some of the world's most important scientific achievements.

The Greek writings on nature study explore the possibility of the use of nature by humans; thus ancient nature study also transmitted practical technical knowledge. This is particularly true of Theophrastos' work on plants: the subject of timber processing, for example, is a major topic in his book about trees (*Historia Plantarum V*). The introduction to this work contains a pronouncement on the subject: "About timber, the characteristics of each [type], the time it must be cut, the purpose to which each is suited, which type is difficult or easy to work and everything else which belongs in this kind of study, this should be described in the same way." Plinius' natural history (*Naturalis Historia*) (first century C.E.), a monumental encyclopedic work that provides a comprehensive overview of ancient knowledge of astronomy, geography, zoology, botany, pharmacy, and mineralogy, also provides a lot of information on technology and the history of inventions. Plinius is interested not only in describing nature itself but

also in presenting its use by humans; he mentions various technical innovations in agriculture and mining in this context.

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Biographical Sketch

Helmuth Schneider was born in 1946 at Bad Gandersheim. He studied history and philosophy in Tübingen and Marburg from 1966 to 1973. He was scientific assistant at the Free University of Berlin from 1978 to 1988 and Private-docent at the University of Heidelberg from 1989 to 1991. Since 1991 he has been chair for ancient history at the University of Kassel and co-editor of *Der Neue Pauly*.