

could be programmed to handle such logics. Kurt Gödel's undecidability proof has ruled out the possibility of an ultimate logic machine capable of following a systematic procedure for testing any theorem in any possible logic, but whether the human brain is capable of doing any kind of creative work that a machine cannot successfully imitate is still an open, much debated question.

See also Aristotle; Boole, George; Bradley, Francis Herbert; Computing Machines; Gödel, Kurt; Gödel's Incompleteness Theorems; Jevons, William Stanley; Logic, History of; Łukasiewicz, Jan; Lull, Ramón; Machine Intelligence; Venn, John.

Bibliography

For a history of logic machines, see Martin Gardner, *Logic Machines and Diagrams* (New York: McGraw-Hill, 1958), and Rudolf Tarján, "Logische Maschinen," in *Digital Information Processors*, edited by Walter Hoffmann (New York: Interscience, 1962), which includes a bibliography of 119 references. Stanhope's machine is discussed in Robert Harley, "The Stanhope Demonstrator," *Mind* 4 (1879): 192–210.

Jevons described his logical piano in "On the Mechanical Performance of Logical Inference" (1870), reprinted in his *Pure Logic and Other Minor Works* (London: Macmillan, 1890); a briefer discussion appears in his *Principles of Science* (London: Macmillan, 1874; reprinted, New York, 1958). Marquand discussed his machine in "A New Logical Machine," *Proceedings of the American Academy of Arts and Sciences* 21 (1885): 303–307. Marquand's machine was praised by C. S. Peirce in "Logical Machines," *American Journal of Psychology* 1 (November 1887): 165–170. Pastore wrote an entire book about his device, *Logica formale, dedotta della considerazione di modelli meccanici* (Turin, 1906). The book was reviewed at length by André Lalande in *Revue philosophique de la France et de l'étranger* 63 (1907): 268–275.

Wolfe Mays, "The First Circuit for an Electrical Logic-Machine," in *Science* 118 (1953): 281–282, and George W. Patterson, "The First Electric Computer, a Magnetological Analysis," in *Journal of the Franklin Institute* 270 (1960): 130–137, describe Marquand's sketches. A description of Macaulay's device is in his U.S. patent, No. 1,079,504, issued in 1913.

Burack first described his 1936 machine in "An Electrical Logic Machine," *Science* 109 (1949): 610–611. Shannon's historic paper on the isomorphism of Boolean algebra and certain types of switching circuits is "A Symbolic Analysis of Relay and Switching Circuits," in *Transactions of the American Institute of Electrical Engineers* 57 (1938): 713–723. The Kalin-Burkhart machine is described in Edmund C. Berkeley, *Giant Brains* (New York: Wiley, 1949). The English three-term machine is discussed in Wolfe Mays and D. G. Prinz, "A Relay Machine for the Demonstration of Symbolic Logic," *Nature* 165 (1950): 197. The Burroughs machine is discussed in A. W. Burks, D. W. Warren, and J. B. Wright, "An Analysis of a Logical Machine Using Parenthesis-Free

Notation," *Mathematical Tables and Other Aids to Computation* 8 (1954): 53–57, and in William Miehle, "Burroughs Truth Function Evaluator," *Journal of the Association for Computing Machinery* 4 (1957): 189–192.

Hao Wang's description of his use of the IBM 704 is in "Toward Mechanical Mathematics," *IBM Journal of Research and Development* 4 (1960): 2–22, reprinted in *The Modeling of Mind*, edited by Kenneth Sayre and Frederick J. Crosson (Notre Dame, IN: University of Notre Dame Press, 1963). On computer simulation, see Allen Newell and H. A. Simon, "Computer Simulation of Human Thinking," in *Science* 134 (1961): 2011–2017, and references cited there. On the Shannon-Moore relay circuit analyzer, see Shannon and Moore's "Machine Aid for Switching Circuit Design," in *Proceedings of the Institute of Radio Engineers* 41 (1953): 1348–1351.

Martin Gardner (1967)

LOGOS

The Greek term *logos* is multiply ambiguous. The unabridged Greek dictionary gives five and a half long columns of definitions and examples. *Logos* is a noun corresponding to the verb *legein* (say), signifying, among other things, speech, statement, sentence, account, definition, formula, calculation, ratio, explanation, reasoning, and faculty of reason. Early studies of the term tended to talk about a concept of *logos*, as if there were some single concept or theory associated with it. In fact, the term was employed in different ways by different thinkers. Yet, there is a kind of interplay in concepts associated with the term that makes a single study worthwhile.

Scholars sometimes speak of a change from *mythos* to *logos*; roughly, a transition in expression from story-telling in myths, usually expressed in poetry, to scientific, philosophical, or historical accounts, usually expressed in prose. Philosophers of the sixth century BCE were among the first Western writers to compose treatises in prose. The new medium of expression permitted a more analytic and detached view of things, and it embodied a revolution in thinking about the world. Although *logos* (plural: *logoi*) could signify a story, increasingly *logoi* were taken to be scientific accounts in contrast to *mythoi* "stories" and *epea* "verses" (see Plato *Timaeus* 26e). But for the sophists, a *mythos* can be used to express a *logos* (Plato *Protagoras* 320c)—but only insofar as *logos* is seen as a more basic kind of explanation.

THE PRESOCRATICS

Logos soon came to signify something of the content of rational discourse as well as the medium, and it is this sense, or set of senses, that this entry will focus on. Hera-

clitus (c. 500 BCE) was the first philosopher to raise *logos* to the level of a principle. He opens his book by saying, “Of this *Logos*’s being forever do men prove to be uncomprehending, both before they hear and once they have heard it. For although all things happen according to this *Logos* they are like the unexperienced experiencing words and deeds such as I explain when I distinguish each thing according to its nature and show how it is” (fr. 1). Heraclitus’s *logos* can be shared with people, and indeed he explicates it in his own treatise; but he anticipates that most people will fail to understand the message. “Although this *Logos* is common,” Heraclitus writes, “the many live as if they had a private understanding” (fr. 2). Somehow the *logos* is publicly available but ignored by the many, who lack philosophical insight. The *logos* has a particular message, or implication: “Listening not to me but to the *Logos* it is wise to agree that all things are one” (fr. 50). Heraclitus regards the *logos* as transcending his own personal communication, and teaching the unity of things.

Heraclitus’s *logos* is a kind of structural principle as well as a message, a reciprocal law of exchange. It has a kind of syntax like language that orders the changes of the world. Heraclitus plays with statements that are syntactically ambiguous, as if to show that the same words can make different statements, which at another level complement each other. So the world is based on a single structure that manifests itself in contraries. Language provides a model for the world.

In the early fifth century BCE, Parmenides presented an argument against change, in the form of a revelation from a goddess. Yet the goddess tells the narrator, “Judge by *logos* the contentious refutation spoken by me” (fr. 7). Here *logos* seems to mean something like *reasoning*, which clearly becomes the key to philosophical truth. For, despite the religious imagery and associations of his poem, Parmenides’s message is above all an argument addressed to the reason.

In the latter half of the fifth century BCE the sophists traveled about Greece teaching practical skills to help young men succeed in politics and, above all, the art of public speaking. They saw a knowledge of *logos*—and especially, for them, the spoken word—as the key to controlling emotions and hence the reactions of audiences to a message. As Gorgias observed, “*Logos* is a great potentate, who by means of the tiniest and most invisible body is able to achieve the most godlike results” (fr. 11, section 8). Sophists composed contradictory arguments (*antilogikoi logoi*) on a single topic to teach skill in argumentation, and sometimes studied elements of language and argumentation.

PLATO AND ARISTOTLE

By the fourth century BCE *logos* is established not only as speech and the like, but as the faculty of reason. Speech becomes the manifestation of reason, and reason the source of speech. According to Plato an understanding of rhetoric presupposes a knowledge of souls—what would later be called psychology—and the use of dialectic to implant truth in souls (*Phaedrus*). In fact, thinking (*dianoia*) is just internal speech (*Sophist* 263e, *Theaetetus* 189e). Thus speech becomes a model for thought, and ultimately a representation for the world; for a sentence (*logos*), such as “Theaetetus is sitting,” is true just in case it correctly describes an action or condition of Theaetetus (*Sophist* 263a–b). In another context, Plato suggests that one can more safely study the world in *logoi* than by means of sensations, and he consequently adopts a method of hypothesis (*Phaedo* 99d–100a).

The sign that one has knowledge is one’s ability to give an account (*logos*) or explanation (*Phaedo* 76b), and one who can give an adequate account is a dialectician (*Republic* 534b). At one point Plato considers as a definition of *knowledge* “true judgment accompanied by an account [*logos*],” but rejects this in part because a satisfactory explanation of *logos* cannot be given independently of knowledge (*Theaetetus* 201c ff.). While the ability to give a rational account provides evidence of knowledge, the account is no mere component of knowledge.

Aristotle accepts Plato’s view of the relation between language and the world along with some of Plato’s terminology (*Categories* 2–4; *On Interpretation* 1–7). He recognizes, if somewhat obscurely, the two relationships that allow language to connect to reality: reference (*semainein*) and predication (*katêgoria*)—the latter primarily a link between a substance and its attributes, but mirrored in the link between grammatical subject and predicate. The basic unit of communication is the sentence (*logos*), which when it makes an assertion (*apophantikos*) is the bearer of truth or falsity. Whereas reference connects words with things, (grammatical) predication asserts that the things are connected in a certain way; if the assertion corresponds to the way things are, it is true; otherwise it is false. Building on this basic theory of language, Aristotle developed the first system of logic, showing how certain propositions follow logically from certain other propositions (*Prior Analytics*). Moreover, he conceived of a science as a set of propositions arranged in a logical order with axioms and definitions as starting points, and theorems as conclusions (*Posterior Analytics* I)—laying out this ideal structure that would be realized by the axiomatization of geometry a generation

or two after his death. Thus in a certain sense Aristotle saw the world as possessing a thoroughgoing logical structure that could be captured in language. Indeed, whereas contemporary logicians often think of logical systems as arbitrary human constructs, some of which are useful for capturing certain linguistic relationships, Aristotle thinks of his logic as having its basis in the nature of things (*Prior Analytics* I 27).

HELLENISTIC PHILOSOPHY

According to the Stoics, the world is ultimately composed of fire, which is identical with God. Fire pervades the world and functions as a world-soul. Reason (*logos*) is found in the world-soul, which orders and controls the world; it is the active principle and is identical with God (Diogenes Laertius 7.134). Soul is found in all animals, and in humans there is also a ruling principle that possesses reason. Thus *logos* in the human mind is like *logos* in the cosmos. Through the activity of fire, reason controls the creation and the history of the world. The world periodically perishes in a conflagration that turns all the elements back into fire, from which a new world arises, seeded by seminal *logos*, a structural principle that directs the cosmogony (Diogenes Laertius 136). The events of the world are ultimately under the control of reason, so that the world is governed by providence (Diogenes Laertius 138–9). The Stoics distinguish between uttered discourse (*prophorikos logos*) and internal discourse (*endiathetos logos*); the former humans have in common with parrots, but the latter is peculiar to humans (Sextus Empiricus *Against the Professors* 8.275).

Philo of Alexandria (early to mid-first century CE), combining Judaism and Platonism by using Plato's theory to explicate the Bible, recognizes *logos* as an image of the invisible God, and human beings as created in the image of the *logos* (*On Dreams* 239, *The Confusion of Tongues* 147). God also acts by his word, for "His word is his deed" (*The Sacrifices of Able and Cain* 65). The world is itself the product of a plan in the mind of God, consisting of the Platonic Forms (*On the Creation* 17–19), which are thus conceived of as present in the mind of God. From this model of the world the creator makes first an invisible world, then a visible one (29–36).

CHRISTIANITY AND NEOPLATONISM

The Gospel according to John begins by affirming the central role of the *Logos*, or Word: "In the beginning was the Word, and the Word was with God, and the Word was God. ... All things were made by him; and without him was not any thing made that was made. ... And the Word

was made flesh, and dwelt among us" (John 1.1, 3, 14). It may be that the *Logos* of John derives from Jewish rather than Greek conceptions, yet the notion was close enough to Greek philosophical conceptions to allow early Christian thinkers to see in it a point of contact between their scriptures and pagan philosophy. They saw Philo as an inspired writer who shared their vision of the Word of God as an intermediary between God and humans. Jesus of Nazareth was the Word of God, who manifested the power of God on earth and prepared the way for his disciples to become sons of God (1.12).

In the mid-second century Justin Martyr identifies Jesus as the *Logos* that wise men, including philosophers, partake of. He finds references to the *Logos* in Plato's *Timaeus*, and more general instances of divine reason in Heraclitus and the Stoics (*First Apology* 5, 40; *Second Apology* 8, 10, 13). He explains that Christians "call Him [Jesus] the Word, because He carries tidings from the Father to men: but maintain that this power is indivisible and inseparable from the Father" (*Dialogue with Trypho* 128). In the most systematic statement of the early church fathers, Origen (third century), commenting on the opening lines of Hebrews, says that Jesus as Word is the invisible image of the invisible God—apparently apprehensible only by reason—who "interpret[s] the secrets of wisdom, and the mysteries of knowledge, making them known to the rational creation" (*On Principles* 1.2.6–7).

Plotinus borrowed from the Stoics at least the general conception of *logos* in a seed to account for the influence Soul has on the visible world. The world "was ordered according to a rational principle [*kata logon*] of soul potentially having throughout itself power to impose order according to rational principles [*kata logous*], just as the principles in seeds shape and form living creatures like little worlds" (*Enneads* 4.3.10). This also helps one understand how Mind orders things by comparing its operation to that of a seed with a rational principle; in such a way reason (*logos*) flows out from Mind to the world (3.2.2). And one can understand how timeless realities have foresight over the world of change by supposing that events unfold according to an archetype, which is effortlessly realized by the imposition on matter of rational principles (4.4.12). Indeed, Plotinus proclaims in a theodicy, "The origin [of events in the world] is *logos* and all things are *logos*," even if they seem to be irrational or evil to our limited view (3.2.15).

In the early fifth century Augustine argued that a word in the heart precedes the articulate word of speech. This inner word is a likeness of the Word of God, by whom God carried out the creation of the world, and

which came to be embodied in flesh in a way analogous to that in which the inner word becomes articulated in language. Thus the preverbal cognition that humans have in themselves an image of the Word of God (*On the Trinity* 15.11.20).

Although in Greek philosophy many different versions of how language, reason, and rational principles connect with the world can be found, what is remarkable is the widespread commitment to some view whereby reason is imbedded in the cosmos. Human reason does not simply impose some extraneous order on the world, but it discovers in nature a structure that mind has in common with the world.

See also Aristotle; Augustine, St.; Diogenes Laertius; Hellenistic Thought; Heraclitus of Ephesus; Neoplatonism; Parmenides of Elea; Patristic Philosophy; Philo Judaeus; Plato; Platonism and the Platonic Tradition; Plotinus; Semantics, History of; Sextus Empiricus; Sophists; Stoicism.

Bibliography

- Aall, Anathon. *Geschichte der Logosidee in der griechischen Philosophie*. 2 vols. Leipzig, Germany: O. R. Reisland, 1896–1899. Reprint, Frankfurt, Germany: Minerva, 1968.
- Boeder, Heribert. “Der frühgriechische Wortgebrauch von *Logos* und *Aletheia*.” *Archiv für Begriffsgeschichte* 4 (1959): 82–112.
- Frede, Michael, and Gisela Striker, eds. *Rationality in Greek Thought*. Oxford: Clarendon Press, 1996.
- Kittel, Gerhard, et al. “Lego.” In *Theologisches Wörterbuch zum Neuen Testament*, edited by Gerhard Kittel, vol. 4, 69–140. Stuttgart, Germany: W. Kohlhammer, 1942. Abridged in *Theological Dictionary of the New Testament*. Translated by Geoffrey W. Bromiley, 505–514. Grand Rapids, MI: W. B. Eerdmans, 1985.
- Mourelatos, Alexander P. D. “Heraclitus, Parmenides, and the Naïve Metaphysics of Things.” In *Exegesis and Argument*, edited by E. N. Lee, A. P. D. Mourelatos, and R. Rorty. Assen, Netherlands: Van Gorcum, 1973.
- Robb, Kevin, ed. *Language and Thought in Early Greek Philosophy*. La Salle, IL: The Hegeler Institute, 1983.

Daniel W. Graham (2005)

LOISY, ALFRED (1857–1940)

Alfred Loisy, the French biblical exegetist, was the best-known and most controversial representative of the Modernist movement in France at the end of the nineteenth and beginning of the twentieth centuries. His scholarly investigation led him to the kind of destructive criticism

of the Gospel narratives and Christian dogmas carried on earlier by such scholars as D. F. Strauss and Ernest Renan, whose lectures at the Institut Catholique Loisy attended from 1882 to 1885. Loisy’s long career, from his entry into the priesthood in 1879 to shortly before his death, was one of much controversy and progressive estrangement from personal religion.

Loisy was born at Ambrière, Marne, and died at Cefonds, Haute Marne. He became professor of Hebrew in 1881, and of Holy Scripture in 1889, at the Institut Catholique. Loisy’s views on the date of the book of Proverbs soon aroused misgivings, and he was warned that continuation of such unorthodoxy would place him in danger of official censure.

Loisy’s superior, Monsignor d’Hulst, was an enlightened man and not intolerant of the work of the modern critical school, but as head of the Institut Catholique he was in a responsible and difficult position. The head of the College of St. Sulpice had forbidden his students to attend the heterodox Loisy’s lectures, and when in 1892 Loisy started his own periodical, *L’enseignement biblique*, for the instruction of young priests, d’Hulst felt obliged to urge caution. In 1892, soon after Renan’s death, d’Hulst himself wrote an article on Renan in *Le correspondant*. Without condoning Renan’s break with Catholicism, d’Hulst upheld his complaint, in *Souvenirs d’enfance et de jeunesse*, that the instruction given at such seminaries as St. Sulpice was out of touch with modern scholarship and the modern world. A further article by d’Hulst, aimed at promoting tolerance of the more searching kind of biblical criticism, gave offense in orthodox quarters, and d’Hulst felt obliged to clear his institute of any suspicion of unorthodoxy. Therefore, when Loisy continued to declare his critical independence of dogma and revelation, and to present a historical Jesus apart from the Christ of faith, he was forced to resign his chair in 1893.

As a reply to modernist exegesis, the pope issued the encyclical *Providentissimus Deus* (November 18, 1893), denying that error is compatible with divine authorship. Loisy wrote to Leo XIII, professing submission to the encyclical’s demand that the truth of the Bible should not be questioned. His insincerity can be inferred, however, for his activities remained unchanged. In fact, on receiving a reply in a mollified tone that invited him to devote himself to less contentious studies, Loisy openly expressed his impatience.

Loisy criticized the Protestant scholar Carl Gustav Adolf von Harnack’s *Wesen des Christentums* (Leipzig, 1900) in his *L’évangile et l’église* (Paris, 1902), which was condemned by the archbishop of Paris as undermining