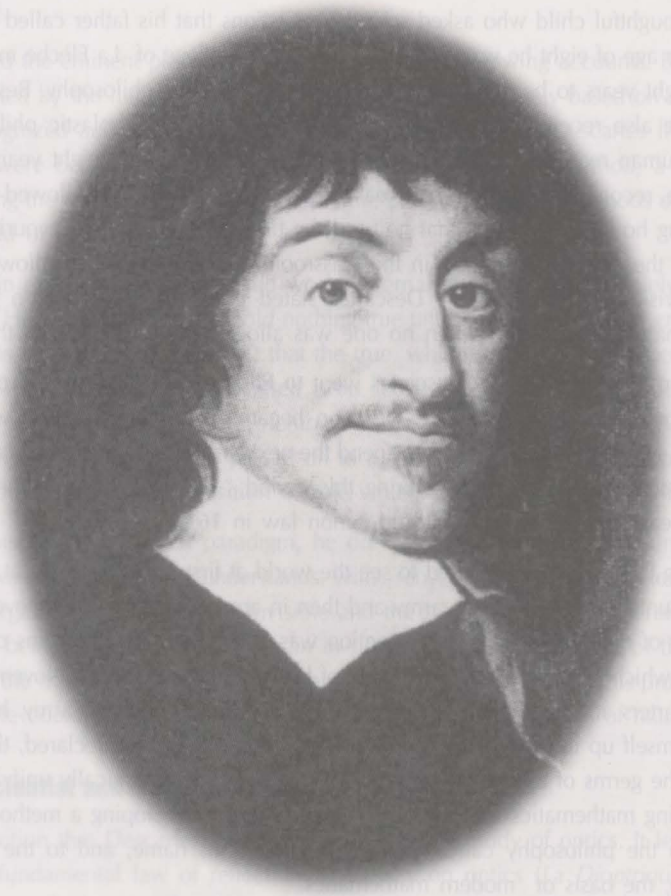
# René Descartes

( 1596 - 1650 )



*"Socrates used to meditate all day in the snow, but Descartes's mind only worked when he was warm."*

**- Bertrand Russell**

***by Desmond W.T. Soh and Sparlo Y.T. Soon***

***Editor's note:*** *The Medley presents to its readers the following tribute to René Descartes, in celebration of the 400th anniversary of his birth.*

René Descartes (31.3.1596 - 11.2.1650) was a famous French philosopher, scientist and mathematician. Writing at the beginning of the scientific revolution, Descartes made major contributions to both philosophy and mathematics. He was one of the most important and influential thinkers in human history and is sometimes called the founder of modern philosophy.

Descartes was born at La Haye, a small town about 200 miles southwest of Paris, in Touraine (a region and former province of France). He was the son of a minor nobleman and belonged to a family that had produced a number of learned men. His mother died of tuberculosis shortly after he was born. He inherited the disease from his mother and as an infant he was pale and weak that the physician offered no hope of saving him. Fearful of losing him, his father kept careful watch over his son's delicate health.

Descartes was a thoughtful child who asked so many questions that his father called him "my little philosopher". At the age of eight he was enrolled in the Jesuit College of La Flèche in Anjou, where he remained for eight years to be educated in traditional Aristotelian philosophy. Besides the usual classical studies, he also received instruction in mathematics and in Scholastic philosophy which attempted to use human reason to understand Christian doctrine. In those eight years, his teachers at the Jesuit College, recognizing his physical weakness and mental alertness, allowed him to remain in bed beyond rising hours. They noted that he used the time meditating and devouring one classic after another while the other boys recited in the classroom. It was a habit he followed all his life. Indeed, when he visited Pascal in 1647, Descartes stated that he could only do good work in mathematics and maintain his health when no one was allowed to get him up in the morning.

Upon his graduation from the college, Descartes went to Paris and fell in with a group of wealthy young men who spent their time gambling. He soon became tired of this life, however, and hid himself away in the suburbs of Paris in order to spend the next two years in mathematical investigation with good Father Mersenne (1588-1648). During this period, Descartes entered the University of Poitiers, where he earned a degree in civil and canon law in 1616.

Instead of practicing law, Descartes decided to see the world at first hand. In 1617, at the age of 21, he enlisted as a volunteer first in a Dutch army and then in armies in Bavaria. However, shortly after and during his tour of duty in the army, his attention was attracted to the problems of mathematics and philosophy, to which he was to devote the rest of his life. On the night of November 10, 1619, while in winter quarters at Neuburg (near Ulm in Bavaria) with the Bavarian army, he escaped the cold by shutting himself up in a "poêle" - an overheated room. There, he declared, three visions or dreams suggested the germs of a new philosophy - an idea of methodologically unifying his various fields of interest using mathematics as a model. He hence began developing a method of reasoning that would lead to the philosophy called cartesianism, after his name, and to the foundation of analytical geometry, the basis of modern mathematics.

After two years as a soldier, Descartes traveled to Italy for a year and settled down in Paris thereafter. While in Paris, he devoted himself to the study and development of his theories and also experimented in the science of optics. In 1628, he moved and settled down in the Netherlands that offered him seclusion and more intellectual freedom. This was the most productive period of his life. Besides continuing with his study and the development of his theories, he also carried on a wide scientific and philosophical correspondence with other leading intellects of Europe. His fame soon spread over all Europe, largely through the efforts of Father Mersenne, who acted as intermediary between the French intellectuals and the cautious Descartes.

## Descartes the philosopher

In the Netherlands, Descartes began work on his first major treatise, *Rules for the Direction of the Mind*. This work, however, was never completed and was published posthumously in 1701. He also withheld the publication of his own work on cosmological theory, *Le Monde* (*The World*), upon hearing of Galileo's condemnation by the Catholic Church in 1633 for defending the Copernican system. He had taken the same position and had been inclined to affirm the Copernican theory of the universe with the concept of a system of spinning planets revolving around the sun. This would have made him equally "guilty" as Galileo. As he always regarded himself as a sincere and devoted

Roman Catholic, he prudently abandoned the project. He wrote sadly to Mersenne, " This has so strongly affected me that I have almost resolved to burn all my manuscript, or at least show it to no one. But on no account will I publish anything that contains a word that might displease the Church." The publication of *Le Monde* had to wait until 1664, well after his death.

However in 1637, upon his friends' persuasion, he finally published the famous *Discours de la Méthode pour bien conduire sa Raison et chercher la Vérité dans les Sciences* (*Discourse on the Method of Rightly Conducting the Reason in the Search for Truth in the Sciences*) accompanied by three essays : *La Géométrie* (an essay on geometry), *La Dioptrique* ( an essay on optics) and *Les Météores* (an essay on meteors). These works described his philosophical speculations and the method of rightly conducting the reason and seeking truth in the Science. With this publication, he established his reputation and gave the world analytic geometry and the philosophy called cartesianism.

Between 1637 to 1644, Descartes also published many other philosophical works. Among them are *Meditationes de Prima Philosophia* (*Mediations on First Philosophy*, 1641) and *Principia Philosophia* (the *Principles of Philosophy*, 1644).

Descartes deserved the eminent place accorded to him on the following accounts. Before his time, philosophy had been dominated by the method of Scholasticism, which was entirely based on comparing and contrasting the views of recognized authorities, particularly the church. However, Descartes lived at a time when these traditional ideas were being questioned. Hence he sought to devise a method, a philosophy of 'systematic doubt', for reaching the truth by attempting to apply the rational inductive methods of science and mathematics to the various field of ideas.

He tried to explain everything in the created world external to human beings solely by the shapes, sizes and motion of bodies. He was determined to hold nothing true until he had established grounds for believing it true. Descartes was thus led to a single sure fact that the true, which could be guaranteed, will be the existence of his own self. The reason being that doubt itself is an act of thought and thought does not take place without oneself. This was expressed by him in the famous words "cogito ergo sum". [I think, therefore I am.] After establishing the ground rules, Descartes passed on to a search for other irrefutable propositions. Each problem that he solved would become a proposition or rule which served afterwards to solve other problems.

Using "I think, therefore I am" as a paradigm, he drew a distinction between mind and body. A mind is a conscious or thinking being in that it understands, wills, senses and imagines, while a body is a being thought of in sensory or organic terms. Minds are invisible and the "I" of the "I think, therefore I am" is the mind and can exist without being extended, so that it can in principle survive the death of the body. In another word, he was accepting the traditional religious doctrine of the immortality of soul. This provides him with the certain fact from which he could deduce the existence of God and the basic laws of nature.

### Descartes the scientist and mathematician

A notable contribution that Descartes made to science was his study of optics. It led him to the independent discovery of the fundamental law of reflection. His essay on optics (*La Dioptrique*) was the first published statement of this law which stated that the angle of incidence is equal to the angle of reflection. He also sought values for c, the speed of light, but was only able to set crude lower limits of c. Besides that, the essay contains an account of the law of refraction, the anatomy of the human eye, and the shape of lenses. His treatment of light as a type of pressure in a solid medium paved the way for the wave theory of light.

In mathematics, Descartes is famous for the unification of algebra and geometry in the form of analytic or coordinate geometry. Most of his contributions in mathematics can be found in the *La Géométrie*. Descartes fully appreciated the power of his new method in geometry. In a letter to Mersenne, after saying "I do not enjoy speaking in praise of myself," Descartes continued: "...what I have given in the second part on the nature and properties of curved lines, and the method of examining them, is, it seems to me, as far beyond the treatment in the ordinary geometry, as the rhetoric of Cicero is beyond the *a, b, c* of children." *La Géométrie* consists of three parts, of which the first two are devoted mainly to applying algebra to geometry, while the third treats the theory of equations. He reduced the solving of geometric problems to the solving of algebraic ones by choosing one of the given lines, say *AB*, and a fixed point on it, say *A*. The position of an arbitrary point *C* was then determined by the lines *AB* and *BC* and he called the segment of the line *AB* between *A* and *B*, *x* and called *BC*, *y*. The lengths and the positions of the other lines and points were expressed in terms of *x* and *y*; and by the conditions of the problem, an equation of the curve is obtained. In doing so, the geometrical

relationships between the points are equivalent to algebraic relationships by means of algebraic calculations. Descartes did not formally introduced a second axis, the *y*-axis, and the name *coordinate* also did not appear in his work. (The term *coordinate* is due to Leibniz (1646-1716)). However, the germinal idea of a coordinate system and the noble idea of transforming the geometric problems into the algebraic ones were first introduced by Descartes.

In algebra, Descartes promoted the use of letters of the alphabet to designate both unknown and known quantities for algebraic operations. In fact, he had an intuitive understanding of the elusive concept 'variable'. Vièta before him had used letters to denote arbitrary constant numbers but it was Descartes who clearly recognised the distinction between variables and arbitrary constants. This significantly advanced the development of calculus (Bell, 1945). Descartes also devised the notation: $x$, $x^2$, $x^3$, $x^4$,... to express the powers of numbers.

The last part of *La Géométrie* belongs to the theory of equations. He recommended that all terms should be taken to one side and equated with zero. He also formulated the rule of signs for finding the number of what he called "true" (positive) and "false" (negative) roots for an algebraic equation. (Descartes recognized negative roots, but referred to them as 'false' as they were 'moindre que rien', that is, less than nothing). This was the first universally applicable criterion for the nature of the roots of an algebraic equation. The rule states that the number of positive roots (with multiplicity) of a polynomial equation with real coefficients is not more than the numbers of variations of sign in its sequence of coefficients; zero coefficients are disregarded in counting changes of sign. Descartes noticed that the negative roots of $f(x) = 0$ are simply the positive roots of $f(-x) = 0$. Thus, the rule of signs for the number of negative roots is obtained immediately: no equation can have more negative roots than the numbers of variations of sign in the coefficients of the polynomial $f(-x)$. Consider for example, $f(x) = x^3 - 6x^2 + 13x - 10$. Observe that $f(x)$ has two variations of signs (+ - +). Thus, by the rule of sign, it can be concluded that there are not more than two positive roots. However $f(-x) = -x^3 - 6x^2 - 13x - 10$, and there is no variation of sign. Thus $f(x) = 0$ has no negative root. Therefore, the largest possible number of positive and negative roots is two, a sum which is less than the degree of the equation. However, Descartes knew that the total number of roots is equal to the degree of the equation. Hence, he was prepared to recognize the existence of some roots which are neither positive nor negative and called these roots 'imaginary'.

*La Géométrie* was not clearly written. Descartes liked to leave details behind for the readers and as a rule, he gave only indications of proofs. In fact, he did not prove the rule of sign in a general way. In concluding the work, Descartes justified the omissions with the remark that much was omitted "in order to give others the pleasure of discovering (it) for themselves."

In 1649, Queen Christina of Sweden summoned Descartes, against his wishes, to give her instruction in philosophy. The Queen, a rugged, tireless woman, wished to be instructed three times a week and made Descartes come for her lessons at five o'clock in the morning. Being long been accustomed to lie late in bed, Descartes was taken ill by the rigors of the winter's morning and died of pneumonia soon after on February 11, 1650.

René Descartes was, indeed, the most dominant thinker of the 1600s. It is curious that this man who brought fame to France lived nearly all his productive years beyond her borders, taught in none of her schools, and even as a soldier fought in none of her foreign wars. (Burton, 1985). M²

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