Pascal, Blaise (1623-1662)

Place: France

Subject: biography, maths and statistics

French mathematician, physicist, and religious recluse who was not only a scientist anxious to solve some of the problems of the day but also a gifted writer and a moralist. He is remembered not so much for his original creative work - as are his contemporaries René Descartes and Pierre de Fermat - but for his contributions to projective geometry, the calculus of probability, infinitesimal calculus, fluid statics, and his methodology in science generally. Much of his work has become appreciated only during the last 150 years.

Pascal was born on 19 June 1623 at Clermont-Ferrand, the son of a civil servant in the local administration. His mother died when he was only three, and his father - also a respected mathematician - looked after the family and saw to the education of the children. In 1631 they all moved to Paris, where Pascal's sister Jacqueline showed literary talent and Pascal himself displayed mathematical ability. By 1639, when Pascal was 16, he was already participating in the scientific and philosophical meetings run at the Convent of Place Royale by its director, Father Marin Mersenne (1588-1648); some of these meetings were attended also by Descartes, Fermat, and other celebrated figures. The illness and eventual death of his father led Pascal to commit himself to a more spiritual mode of life, one from which he was at times terrified of lapsing. Converted to the rigorous form of Roman Catholicism known as Jansenism in 1646, he finally experienced a fervently spiritual 'night of fire' on 23 November 1654, and from then on wrote only at the direct request of his spiritual advisers, the order of monks at Port Royal. Five years later his health had become poor enough to prevent him from working at all. After 1661, when his sister died, Pascal became even more solitary and his health deteriorated further. His last project was to design a public transport system for Paris. The system was actually inaugurated in 1662, the year Pascal died. He died from a malignant ulcer of the stomach on 19 August 1662 in Paris, aged only 39.

Pascal's first serious work was actually on someone else's behalf. In 1639 Gérard Desargues (1593-1662) published a work entitled Brouillon project d'une atteinte aux événements des rencontres du cone avec un plan/Experimental Project Aiming to Describe What Happens When the Cone Comes in Contact with a Plane, but its content baffled most of the mathematicians of that time because of its style and vocabulary, and the refusal of Desargues to use Cartesian algebraic symbols. Pascal became Desargues's main disciple, and in the following year published his 'Essai pour les coniques' in explanation of the subject. The paper was an immediate success in the mathematical world; that in itself, coupled with the fact that his own algebraic notational system now had strong competition, left Descartes smarting rather, and he thenceforward regarded Pascal as something of an opponent.

Grasping the significance of Desargues's work, Pascal used its basic ideas - the introduction of elements at infinity, the definition of a conic as any plane section of a circular cone, the study of a conic as a perspective of a circle, and the involution determined on any straight line by a conic and the...

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opposite sides of an inscribed quadrilateral - and went on to make his first great discovery, now known as Pascal's mystic hexagram. He stated that the three points of intersection of the pairs of opposite sides of a hexagon inscribed in a conic are collinear. By December 1640 he had deduced from this theorem most of the propositions now known to have been contained in the Conics of the ancient Greek mathematician Apollonius of Perga. It was not until 1648, however, that Pascal found a geometric solution to the problem of Pappus of Alexandria (which Descartes had used in connection with demonstrating the strength of his new analytical geometry in 1637). Pascal's solution was important because it showed that projective geometry might prove as effective in this field as the Cartesian analytical methods.

The full treatise that Pascal wrote covering the whole subject was never published; the manuscript was seen later only by Gottfried Leibniz. And in fact, because the work of Desargues was so complicated, it was not until the 19th century, with the researches of Jean-Victor Poncelet, that attention was drawn to the work of Pascal.

In 1642, to help his father in his work, Pascal decided to construct an arithmetical machine that would mechanize the processes of addition and subtraction. He devised a model in 1645, and then organized the manufacture and sale of these first calculating machines. (At least seven of these ‘computers’ still exist. One was presented to Queen Christina of Sweden in 1652.)

Pascal kept up a long correspondence with Fermat on the subject of the calculus of probabilities. Their main interest was in the study of two specific problems: the first concerned the probability that a player will obtain a certain face of a die in a given number of throws; and the second was to determine the (portion of the) stakes returnable to each player of several if a game is interrupted. Pascal was the first to make a comprehensive study of the arithmetical triangle (called the Pascal triangle) that he then used to derive combinational analysis. Together with Fermat, he provided the foundations for the calculus of probability in 1657. In 1658 and the next year, Pascal perfected what he called 'the theory of indivisibles' (which he had first referred to in 1654). This was in fact the forerunner of integral calculus, and enabled him to study problems involving infinitesimals, such as the calculations of areas and volumes.

Pascal's work in hydrostatics was inspired by the experiment of Evangelista Torricelli in 1643, which demonstrated that air pressure supports a column of mercury only about 76 cm/30 in high. In 1647, Pascal succeeded in repeating Torricelli's experiment, but this time using wine and water in tubes 12 m/39 ft high fixed to the masts of ships. He confirmed that a vacuum must exist in the space at the top of the tube, and set out to prove that the column of mercury, wine, or water is held up by the weight of air exerted on the container of liquid at the base of the tube. Pascal suggested that at high altitudes there would be less air above the tube and that the column would be lower. Unable through poor health to undertake the experiment himself, he entrusted it to his brother-in-law who obtained the expected results using a mercury column in the mountains of the Puy de Dôme in 1648.

Pascal's proof that the height of a column of mercury does depend on air pressure led rapidly to investigations of the use of the mercury barometer in weather forecasting. Pascal however turned to a study of pressure in liquids and gases, and found that it is transmitted equally in all directions throughout a fluid and is always exerted perpendicular to any surface in or containing the fluid. This is known as Pascal's principle and it was propounded in the treatise on hydrostatics that Pascal completed in 1654. This principle is fundamental to applications of hydrostatics and governs the operation of hydraulic
Pascal's pioneering work on fluid pressure laid the foundations for both hydraulics and meteorology. In his honour, the SI unit for pressure (equal to one newton per square metre) is called the pascal.