Gaspard Monge

French mathematician **Gaspard Monge** (May 9, 1746 – July 28, 1818), one of the most original and productive applied mathematicians of his age, laid the foundations of modern descriptive geometry. He also is considered the father of differential geometry for introducing the concepts of lines of curvature of a surface in 3-space. In 1783, independently of Antoine Lavoisier, he discovered that water resulted from an electrical explosion of oxygen and hydrogen. Monge embraced Lavoisier's new chemistry and was instrumental in getting it accepted. During the Reign of Terror, he was the official recorder of Louis XVI's trial and execution.

Monge, who later in life was made the Comte de Péluse by Napoleon, was born in Beaune, Bourgogne, the son of a poor tradesman. His social status did not hold out much hope for a bright future. Still he showed early signs of mathematical and engineering brilliance and at age 14 constructed a fire engine that was put into service. He was first educated at Beaune at a school run by a religious order and then went to Lyons to study at the Collège de la Trinité.

At 16, one year after he learned physics, Monge was teaching the subject at the school. While home on vacation, Monge drew up a plan of the city, which came to the attention of an officer on the staff at the École Royale du Génie at Mézières. The latter was so impressed that he recommended Monge be admitted to the military school. However, due to his origins, he couldn't receive a commission in the army, then limited to aristocrats and those of higher social classes. He was allowed to work at an annex of the school where surveying and drawing were taught. Being a draftsman wasn't his ambition and he

failed to see why he wasn't sufficiently well born to work with problems requiring calculation. Later he recalled: "I was a thousand times tempted to tear up my drawings in disgust at the esteem in which they were held, as if I had been good for nothing better." Monge spent his spare time developing his own ideas of geometry.

A year later Monge was given the assignment of drawing up a fortification plan to prevent an enemy from either seeing or firing at a military position no matter what the position of the foes. It was expected that he would employ the usual methods known at the time. Instead he developed a graphical solution based on techniques he had developed. At first his plan was rejected because he had taken longer to complete it than allotted. But it soon was clear that his methods were far superior to those taught at the school and his plan was adopted. This led to Monge being appointed professor of descriptive geometry at the École Royale with the understanding that his results were to be a military secret to be shared only with officers above a certain rank. Although he had risen far above his class, his ambition was to make his reputation in the highest mathematical circles. To this end, he submitted four well-received memoirs to the Académie des Sciences on the calculus of variations, the theory of partial differential equations, infinitesimal geometry, and combinatorics.

In 1789 Monge was appointed to a mathematical position in Paris while maintaining his provincial appointment. On July 14, 1789, the Bastille was stormed marking the beginning of the French Revolution. Monge embraced the doctrines of the Revolution, and was appointed to the major Académie Commission on Weights and Measures that formulated the metric system. After further revolutions, in 1792, the monarchy was abolished and a republic was declared. Monge was appointed Minister of the Navy, a post he held for only eight months before resigning because of incessant battles necessary to get anything accomplished. His position in the Revolutionary government was precarious because he was too liberal for the conservatives and too conservative for the extremists. He returned to

his work with the Académie, but in August 1793 the National Convention abolished the Académie des Sciences, although allowing the Commission on Weights and Measures to continue its work.

Monge was a major influence in the establishment of the École Centrale des Travaux Publics (later the École Polytechnique) and was appointed an instructor at the school. His lectures on infinitesimal geometry became the basis of his famous book *Application de l'analyse à la géométrie*. He also gave a course on descriptive geometry at the newly established École Normale. This field, mentioned earlier and once known as stereotomy, is concerned with two-dimensional representations of three-dimensional objects. Plane projections and perspective drawings of solid figures are used to describe and analyze their properties for engineering and manufacturing purposes. Attention is paid to the properties of surfaces, including normal lines and tangent planes.

Modern mechanical drawing and architectural drawing are based on the principles of descriptive geometry. The classical form of these methods was taught in every engineering course of study until the advent of computer graphics, although they remain the fundamental basis of computer graphics and design. Among Monge's problems was to determine the curve of intersection of two surfaces each of which is generated by a line that moves so as to intersect three skew lines in space. Another of his problems was to find the point in space that is equidistant from four lines. A theorem named for Monge states that for three disjoint circles of unequal radii, with no one contained in any other, the pairs of external tangents meet in three points that are collinear.

In 1796, Monge was sent to Italy with chemist Claude Louis Berthollet and some artists as a member of a commission to select the best art treasures for the conquerors to bring back to France. While there he became friends with Italy's conqueror, Napoleon Bonaparte. Back in Paris, Monge was appointed Director of the École Polytechnique and in 1798, he returned to Rome to participate in establishment of

the Republic of Rome. Bonaparte asked Monge to join him on his Egyptian expedition, which he did reluctantly. When Napoleon returned to Paris in 1799, he seized power in a coup, and set up a new government, the Consulate. Monge was named a senator on the Consulate for life. The one-time republican thus joined forces with a military dictator.

About this time Monge's *Géométrie descriptive* was published and in addition to his duties with the Consulate, he was kept busy teaching and writing texts for the students at the École Polytechnique. Although it cost him his health and eventually placed him in fear for his life, Monge supported Napoleon through his various ups and downs. After Napoleon was defeated at Waterloo, Monge fled from France but returned in 1816. He was stripped of all of his honors and positions following the restoration of the monarchy, and he was expelled from the Institut de France, the successor to the Académie des Sciences, which he had worked so hard to establish. From then on until his death he was harassed politically and continually threatened. When he died the students of the École Polytechnique celebrated his life although the French Government had ordered that there be no tribute for him.

A story that reveals the kind of man Monge was deals with the unusual way he met his future wife. While attending a reception Monge overheard a lout slandering a young widow who had rejected him. Though Monge did not know the woman, he read the riot act to the offender and challenged the latter to a duel, which was quickly rejected. Sometime later, at another reception, Monge was captivated by the beauty and charm of a young woman. It was only after he was introduced to Madame Horbon, that he discovered she was the one he had earlier defended. The couple married in 1777, and as she owned a forge, he developed an interest in metallurgy. She outlived Monge and did her best ever after to perpetuate his memory.

Quotation of the Day: "Monge was one of the first modern mathematicians whom we recognize

as a specialist: a geometer – even his treatment of partial differential equations has a distinctly geometrical touch. … In Monge's descriptive geometry lay the nucleus of projective geometry and his mastery of algebraic and analytical methods in their application to curves and surfaces contributed greatly to analytical and differential geometry." – Dirk J. Struik