The roots of industrial engineering: Leonhard Euler – the prolific man

by Paul Kruger

Leonhard Euler, a pioneering Swiss mathematician and physicist, was born in Basel on 15 April 1707 to Paul Euler, a pastor of the Reformed Church, and Marguerite Brucker, a pastor's daughter. Members of the Bernoulli dynasty, in particular Johann Bernoulli (who was at the time regarded as Europe's foremost mathematician), were close family friends.

Euler made important discoveries in fields as diverse as infinitesimal calculus and graph theory. He also introduced much of the modern mathematical terminology and notation. Among his contributions to the language of Mathematics are the basic symbols π, e and i, the summation notation Σ and the standard function notation $f(x)$. He is also renowned for his work in mechanics, fluid dynamics, optics and astronomy.

At the age of 13, Euler was already attending lectures at the University of Basel. He obtained his master's degree in 1723 with a dissertation comparing the natural philosophy systems of Newton and Descartes. In 1726, Euler completed his doctoral thesis on the propagation of sound, entitled *De Sono*. On his father's wishes, Euler furthered his education by enrolling in the theology faculty, but devoted all his spare time to studying Mathematics. He wrote two articles on reverse trajectory. These were highly valued by his teacher, Johann Bernoulli. Bernoulli convinced Euler's father to allow his son to pursue a career in Mathematics. In 1727, Euler applied for a position as professor in Physics at Basel University, but was turned down. During his life, he applied for various positions at the University of Basel several times. This was an appointment he very much coveted, but never successfully obtained.

Although he was born in Switzerland, he is most closely associated with the Berlin of Frederick the Great and the St Petersburg of Catherine the Great. Euler's sight in his right eye deteriorated during his stay in Germany, so much so that Frederick referred to him as 'Cyclops'. Frederick also expressed disappointment with Euler's practical engineering abilities: "I wanted to have a water jet in my garden: Euler calculated the force of the wheels necessary to raise the water to

→ *Leonhard Euler*

a reservoir. The plans for my mill were carried out geometrically and it could not raise a mouthful of water closer than 50 paces to the reservoir. Vanity of vanities! Vanity of geometry!" Tired of the chiding of Frederick and Voltaire, who was also a member of Frederick's court, Euler went to the Imperial Russian Academy of Sciences in St Petersburg on the recommendation of his friend, Daniel Bernoulli, after Daniel's brother, Nicolas, died and Daniel asked him to fill his brother's position in his place. Euler swiftly rose through the ranks in the academy and became professor of Physics in 1731. In 1733, when Daniel left for Basel, Euler succeeded him as professor in the Mathematics department.

He is considered to be the pre-eminent mathematician of the 18th century and arguably one of the greatest of all time. He is also one of the most prolific mathematicians ever, having published more than 800 mathematical papers. Until his death in 1783, the Academy of Sciences in St Petersburg was presented with over 500 of his works. The academy continued to publish them for another half century after his death. He and his wife had 13 children, of which only five survived childhood.

Euler's eyesight worsened further throughout his mathematical career.

In 1735, he became nearly blind in his right eye and later suffered a cataract in his good left eye, rendering him almost totally blind in 1766. Even so, his condition appeared to have little effect on his productivity. With the aid of his scribes, Euler's productivity in many areas of study actually increased. He produced on average one mathematical paper every week in 1775!

Richard Feynman called the formula, known as Euler's identity $(e^{i\pi} + 1 = 0)$, "the most remarkable formula in Mathematics" for its single use of the notions of addition, multiplication, exponentiation and equality, and the single use of the important constants 0, 1, e, i and π. Euler, a simple religious man and a hard worker, was very conventional in his beliefs and tastes and is commemorated by the Lutheran Church on their Calendar of Saints on 24 May.

"Liesez Euler, Liesez Euler, c'est notre maître à tous."
(Read Euler, read Euler, he is our master in everything.)
Pierre Simon Laplace

"He remains living in thought in terms of the splendid example he provided of a mind capable of movement without friction and so achievement without effort."
– David Berlinski