AUGUSTA ADA LOVELACE (1815–1852)

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BIOGRAPHY

Augusta Ada Byron Lovelace was the only child of the short, tempestuous marriage of Anna Isabella (Annabella) Millbanke and the poet George Gordon, the sixth Lord Byron. They were married in January 1815, and their daughter, Ada, was born in London on December 10, 1815. Only thirty-six days after Lovelace's birth, Lord Byron left England, never to see his wife and child again. However, less than a year after leaving England, Byron wrote about his daughter in the opening line of Canto Three of his epic *Childe Harold's Pilgrimage*. Byron was exiled in Greece for the next eight years, until his death in 1824. He frequently wrote to his wife and sister for news of his daughter, and on his deathbed his last words were about her.

Lovelace was raised by her mother, who encouraged her mathematical aptitude. Lady Byron herself had been known for her mathematical ability, and early in their courtship, Lord Byron had called her his "Princess of Parallelograms." It was not surprising, then, that the young Lovelace received more than the usual mathematical education given to young girls of her class during the 1800s.

Lovelace never attended any school or university. Her education was provided by governesses, tutors, and self study. Her mathematics education was received primarily from William Frend. Family friends, such as Mary Somerville* and Augustus De Morgan, often consulted and gave advice to Lovelace about mathematical questions.

In May 1833 Lovelace was presented at court and attended numerous balls, where she met many famous people. However, the party which significantly affected her career took place in June 1833. There she met Charles Babbage, who was to be a major influence in her life. Other social acquaintances present at this party included Augustus De Morgan and Mary Somerville. All of these mathematicians advised and encouraged Lovelace in her mathematical career, but it was Babbage whom she turned to for scientific training and whose disciple she became.

Lovelace often attended parties at the Babbage home, and in 1835 Babbage first began corresponding to Lovelace about these parties. It was at one of them that Lovelace first developed her interest in Babbage's Difference Engine. She attended lectures on it given by Dionysius Lardner at the Mechanic's Institute. The Difference Engine, never completed by Babbage, was to be an automatic machine for calculating and printing mathematical and astronomical tables. The construction of this calculating machine drew inspiration from the Jacquard loom and led to Babbage's design of a program-controlled computer called the Analytical Engine.

In 1835, when she was nineteen, Lovelace married William, Lord King, who was thirty. William was named the first Earl of Lovelace three years after their marriage. Although the earldom was ostensibly given for his work in the foreign service, it was assumed that the Byron family connections were really responsible (the prime minister was Lady Byron's first cousin).

Lovelace had two sons and a daughter: Byron Noel (1836), Anne Isabella (1837), and Ralph Gordon (1839). Lovelace had never been physically strong, and giving birth to three children in three years further weakened her.

Shortly after the birth of her last child, Lovelace asked Babbage to find a mathematics tutor for her. Eventually, in 1840, Augustus De Morgan agreed to tutor Lovelace. In the same year Lord Lovelace was made a Fellow of the Royal Society. Through him Lovelace now had access to numerous books and papers. At this point Lovelace became totally immersed in mathematics, and, in addition to her studies, offered to work with Babbage on his Analytical Engine, the general-purpose calculating machine to operate from punched cards. She left her children's upbringing to her husband, her mother, and servants, a practice not uncommon for the English upper classes. The major career difficulty encountered by Lovelace was the social pressure against using her name in connection with her scientific endeavors. When her major work was published, initials were used instead of her name.

It is believed by some that in her later years Lovelace attempted to use the Analytical Engine to develop a system for gambling on the horse races. Although there were financial losses and familial difficulties in Lovelace's later years, there is no concrete evidence to support this claim.

Lovelace's health, weakened since her childbearing years, continued to deteriorate, until in the later years of her life she was forced to stay in London to be near doctors. Her condition was eventually diagnosed as cancer, and she died, after months of suffering, in 1852, at the age of thirty-six. At her request Lovelace was buried next to her father, in the Byron family vault in Hucknall Torkard Church in Nottinghamshire.

WORK

Lovelace's major work was the translation and notes on a paper by L. F. Menabrea about the Analytical Engine. Menabrea was an Italian mathematician who

heard Babbage speak on the Analytical Engine in Turin. In 1842 Menabrea's paper was published in French in the *Bibliothèque Universelle de Genève*. Lovelace, who was fluent in French, proposed to translate the paper into English. Babbage suggested that she write her own paper or else notes to the Menabrea paper. She did the latter, providing also the illustrations and the solution to algebraic problems as applications of the Analytical Engine. The notes developed the subject of programming in great detail, and the resulting work was significantly longer than the original paper. According to Babbage, the Menabrea and Lovelace articles together indicated that the sequencing of arithmetic operations could be done by machinery.

There was a significant mathematical, as well as personal, correspondence between Babbage and Lovelace during the period when she was working on the article. The development of the mathematical analyses can be seen in this correspondence, especially the program she developed with Babbage to compute Bernoulli numbers.

Lovelace compared the Difference Engine and the Analytical Engine. She demonstrated the superiority of the Analytical Engine by showing that rather than computing the result of only one particular function, it could develop and compute results for any function. She described the use of cards to determine the mathematical operations to be used, and introduced variable cards and operation cards. Each operation card defined one of the four arithmetic operations (addition, subtraction, multiplication, division), and any calculation could be represented as a sequence of operation cards. The variable cards indicated the operands of each operation. Each arithmetic operation has three operands; for example, addition has two summands and a sum. Thus each operation card had three variable cards. As examples, Lovelace derived the operation cards needed to solve specific algebraic and trigonometric equations. She described two important programming techniques, known today as looping and recursion, and how they could be accomplished on the Analytical Engine. She also alluded to another programming technique now known as selection: "The engine is capable, under certain circumstances, of feeling about to discover which of two or more possible contingencies has occurred, and then of shaping its future course accordingly" ([1843] 1982, 10, footnote). She explained how the Analytical Engine could use looping to solve a set of nine simultaneous linear equations, and actually wrote out a program to calculate the Bernoulli numbers recursively.

The paper and the notes were published using the initials A.A.L. There was much speculation over the identity of the author. However, those who knew Lovelace offered their congratulations on the value of the notes. Both De Morgan and Somerville praised the work highly. De Morgan further wrote to Lady Byron about his high estimation of her daughter's abilities. Babbage himself felt that the notes were the most comprehensive analysis of the power of his Analytical Engine. To acknowledge Lovelace's contribution to the development of the field of programming and the documentation of Babbage's work, the 1980s programming language Ada was named after her.

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