ADA LOVELACE'S POETICAL SCIENCE

by Betty Alexandra Toole Ed.D.

Dr Toole is the author of Ada, The Enchantress of Numbers, Strawberry Press, 1992, revised edition, 1998 in addition to over 20 articles about Ada Lovelace including a co-authored article in the May, 1999 issue of Scientific American. She attended the University of Chicago and received bother her bachelors and doctorate degrees from the University of California at Berkeley. She is currently writing a young adult book about Ada Lovelace.

Abstract:

Ada Lovelace added notes in 1843 to a description of Charles Babbage's Analytical Engine including a table for the calculating of Bernoulli numbers. In addition, she predicted some of the impact of today's computer revolution. Her ability to choose the most appropriate "program" for an "information machine" as well as to see its advantages and disadvantages under scored her ability to integrate both poetry and science and has stood the test of time.

Keywords: Ada Lovelace, Charles Babbage, Analytical Engine, Poetical Science

It is fitting that this paper is delivered in Greece because my commitment to exploring this story began on a flight between Athens and Cairo in January 1984. It was triggered by an article in the Herald Tribune and a conversation which reduced mathematical ability to differences between male and female, digital and analog thinking. I thought it was far more complicated and that Ada Lovelace's story might reveal a different approach.

My journey on her path began when I was writing my doctoral dissertation. I went to visit the exhibit of calculating devices at the Science Museum, in London, and next to a model of Charles Babbage's Analytical Engine, which is now heralded as the first computer, was the portrait of a lovely Victorian lady. It was stated that she was Augusta Ada Byron, Lady Lovelace, who wrote a description, in 1843, of Babbage's plans for the Analytical Engine. She was Lord Byron's daughter. This strange combination of poetry and science intrigued me!

Yet it seems to me that it was this combination that enabled Ada not only to see the value of Babbage's plans but to predict accurately some of the potentialities and ramifications of those ideas. Ada, just like her father, had the ability by using imagination and metaphor to evaluate accurately a concept or an idea. In Ada's case she applied this talent to the description of a technological innovation which still has meaning today. It is not a trivial trait for either a poet or a scientist to get to the heart of the matter simply, succinctly and successfully. These may be just the skills we need today to determine the value of everything from the printed word to the computer printout; poetical or analog skills in a digital world.

The conflict between science and poetry in the history of western civilization is well known. It is here in Greece that the conflict began. Plato viewed poetry with suspicion and banned it from his utopian Republic, because it “gives no truth of its own, stirs up the emotions, and thereby blinds mankind to the real truth.” To Plato, truth was absolute and poetry a mere illusion. Aristotle did not agree. To him poetry had a positive value; “It is a great thing, indeed, to make proper use of the poetic forms . . . But the greatest thing by far is to be a master of the metaphor.”(Poetics 1459a); “ordinary words convey only what we know already; it is from metaphor that we can best get hold of something fresh.” (Rhetoric 1410b)

The separation between these two views become formalized at the beginning of the Industrial Revolution into theories of objectivism and subjectivism. The allies of objectivism were scientific truth, digital skills and reason. These empirical skills were in contrast to subjectivism, which came to be associated with analog skills, emotions, imagination, intuitive insight and “higher truth.” With the development of technology and its dehumanizing influence, that Byron so ardently complained about in his maiden speech before Parliament, the Romantic poets left reason, science and technology to the empiricists and left the mainstream of society to follow their own path. In Byron's case, the fight for freedom was in a foreign place, here in Greece, not his home territory.

For Ada, these philosophical speculations were not remote but the battleground of her life. Her mother, Lady Byron, had the reputation of being a fine mathematician and her father was the famous poet. Ada's struggle to unite the conflicting strains in her background was especially difficult, since her parents separated when she was only five weeks old. Yet her father's heritage could not be ignored. In frustration, Ada verbalized this struggle when she wrote, in an undated fragment, to Lady Byron, “You will not concede me philosophical poetry. Invert the order! Will you give me poetical philosophy, poetical science?”(p.10) Lady Byron never saw the connection.

The Mathematical Education of Lord Byron's Daughter

Mathematical understanding is not just reflected in formal but in informal activities as well. In the 20th century, it can no longer be judged on the ability to add long columns of numbers (calculators can do that), or on substituting a variable in functional equation (computers can do that). A much broader view is needed to determine and promote mathematical and scientific understanding. Not only the "digital" or traditional skills, emphasizing accuracy in details, analysis and reason are key to mathematical understanding, but also the so called “analog” or poetical skills of imagination, visualization, patterning and the use of metaphor. Ada's formal education emphasized traditional skills, but the “evil” influence of her father's heritage kept slipping through. Luckily, Lady Byron did not realize, since her vision was so narrow, that Ada's mathematical ability and perception was as much her father's as her mother's legacy.

When Ada was twelve years old, this future “Lady Fairy” as Charles Babbage affectionately called her, decided that she wanted to fly. Ada went about the project methodically, thoughtfully, with imagination and passion. Her first step in February, 1828, was to construct wings. She investigated different material and sizes. She considered various materials for the wings; paper, oilsilk, wires and feathers. She examined the anatomy of birds to determine the right proportion between the wings and the body. She decided to write a book Flyology illustrating, with plates, some of her findings. She decided what equipment she would need, for example, a compass, to “cut across the country by the most direct road,” so that she could surmount mountains, rivers and valleys. (p.34) Her final step was to integrate steam with the “art of flying.”

It was like the realization of a dream when Ada met Charles Babbage and his Difference Engine in 1833. Babbage was a mathematical and technological genius. As a result of their meeting, Ada was inspired to study mathematics and science - not as a duty - but as a joy. Ada even took upon herself the task of teaching the recalcitrant daughters of Lady Gosford.

As a mathematics teacher of two upper class, bored, students Ada's ability effectively to integrate “analog” and “digital” skills comes through in her correspondence. She used every method she could to get across her mathematical message. First she tried to build an esprit de corps. Her letters were “a `Sentimental Mathematical Correspondence between two Young Ladies of Rank' to be hereinafter published no doubt for the edification of womankind . . . Ever yours mathematically.” (p.62) Ada, in teaching the concept of an inflected line, started by defining the word, explaining its derivation and showing how it was used. Then she evoked the visual. She drew five diagrams and encouraged her students to use Cambridge quire paper which was especially suited for drawing. She suggested that they use colored pens, rulers and compasses, which were then considered “vulgar instruments.” Ada paid attention to detail, as well, and when diagrams were not distinctly labeled, Ada scolded her students. However, the gravest sin, according to Ada, was using an indirect proof when a direct proof could have been used. Then metaphor slips into the conversation. Ada tried to show her students the “beauty” of mathematics; how nothing was done without a reason, and that they should watch how the theorems “dovetailed.”

As an adolescent Ada naturally was concerned about her imagination running wild. Dr. King, her very proper mathematics teacher, suggested mathematics as a cure since it had nothing to do with human emotions or "imagination." However, that "evil" imagination slipped through, since Ada responded that she never understood a geometric proof unless she imagined it in her head. As for emotions, they were now directed into a passion to find out as much as she could about Babbage's first calculating engine, the Difference Engine. She read an article by Dionysius Lardner, attended his lectures at the Mechanics Institute, received explanations from Babbage and even borrowed the plans of the engine.

By late 1834, Babbage began to conceive an idea for another calculating engine, the Analytical Engine. Ada was witness to Babbage's speculations and ideas for this revolutionary development in the history of computing devices at a dinner party given by Mary Somerville, a prominent scientist. Mrs. Somerville cautioned Babbage that people were not ready for such innovative ideas. Ada, however, had a different response and was touched by the "universality" of Babbage's ideas. Babbage, at this time, began to formulate plans and designs for the Analytical Engine.

In February 1840 Ada wrote Babbage a letter wondering whether the board game "Solitaire" could be written out mathematically. She started with the process of numbering each peg and describing clearly each move. Ada's idea predates Boole's first published work in 1847, a pamphlet, "The Mathematical Analysis of Logic," which with his other works, formed the foundation for our being able to "program" games on our modern computer.

In the fall of 1840, Ada returned to the formal study of mathematics, after a five year absence, with Augustus De Morgan, a prominent nineteenth-century mathematician. The instruction took place primarily by mail with Ada asking questions about a text, which De Morgan would then answer. When Ada had difficulty understanding functional equations, she wrote De Morgan; "functional Equations are complete Will-o-the-wisps to me. The moment I fancy I have really at last got hold of something tangible and substantial, it all recedes further and further and vanishes again in thin air." (p.173)

At first glance it appears that Ada does not understand functional equations; however, a closer analysis reveals that she went straight to the heart of the matter. In this era of quantum physics we know the difficulty of measuring a point and a wave at the same time. The dilemma relates to the difficulty in measuring a wave function which changes continuously and casually, (measuring at two specific points separated by time) and discontinuously and erratically, as a result of observation. The difficulty in observation is termed "the collapse of the wave-function." it is fascinating that the collapse Ada feels in her verbal metaphor of tangibility is suggestive of a problem for the mathematical metaphors of modern physics.

The literary fragments of Ada's correspondence with De Morgan show that in addition to studying calculus she was also learning about Bernoulli numbers and Matrix Algebra. It is at this time, at the end 1842 or the beginning of 1843, that Ada translated Menabrea's description, written in French, of Babbage's Analytical Engine. When Babbage saw the translation he wondered why Ada had not written an original work, and when she rejected that idea he suggested that she add notes to the translation.

“The Power of This Baby Will Grow”

Ada approached the Notes in the same manner that she approached flying, teaching mathematics, and her correspondence with De Morgan. She used both analog and digital skills. She started by stating the overall issue and then defined terms. Babbage was particularly pleased with her “Philosophical Note A.” The main problem, to Ada, was to describe the Analytical Engine and contrast it with Babbage's previous calculating engine, the Difference Engine. The Difference Engine was designed to calculate a specific function, whereas the Analytical Engine was designed for calculating any algebraic function and, most important, it could deal with conditional operations. The Analytical Engine gained tremendous power by making a clear distinction between operations and numbers, differentiating, for example, between whether “2” stood for the number “2,” or squaring a number.(p.244)

Another powerful difference between the two engines was how they received information. The Analytical Engine received information about numbers, variables and operations to be performed from a series of punch cards similar to the Jacquard punch cards used to instruct the looms. Ada, by use of metaphor, explained accurately the function when she stated “the Analytical Engine weaves algebraical patterns just as the Jacquard-loom weaves flowers and leaves.” Ada also speculated, using her vivid imagination, about the possible uses of the engine. Her statement has been quoted often: “Supposing for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expressions and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent.”(p.245)

The Analytical Engine, unlike the modern day computer, did not have an internally stored program; however, it could store numbers. The engine could receive information about the “program” by the use of cards. It was possible to arrange the cards so that the engine could do a long complicated program, involving cycles and loops without human intervention. Ada suggested to Babbage that the Bernoulli numbers would be an excellent example for such a program. In order to calculate Bernoulli numbers it is necessary to use various operations in different sequences. Ada started the tables, to show how the engine would receive instructions, but according to Babbage's autobiography he completed them, though Ada mercilessly pointed out the errors he had made. However, the evidence at the time in Ada's correspondence, gives a different impression. She wrote she had completed the table and that her husband Lord Lovelace was inking the table over. (p.199)

There are other "programs" in Menabrea and Ada's notes which some people use to discredit her contribution to the first published program. Without footnoting scholars have referred to them. I checked them out in the files at the Science Museum, and they are puzzling. They are simple, do not include indices which Ada suggested, nor do they involve complex algorithms as are found in Ada's suggestion, the table for Bernoulli numbers. Another strange thing, which I am investigating in July, 2001, the previous programs which are in Babbage's files, but not in Babbage's handwriting. At the conference I will show these programs, which formed the visual background of the article I co-authored for *Scientific American* in May, 1999.

It is easy when dealing with a revolutionary idea, like the Analytical Engine, to attribute to it all sorts of powers. Though Ada recognized that the engine had both a practical and theoretical potentiality, she cautioned that it should be neither under or overvalued: "The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform." (p.257) This issue is still hotly debated today.

When Ada and Babbage were working on the Notes, Ada felt that she was "flying" and Babbage called her "Lady Fairy." As they were completing the Notes, disputes arose: Babbage however remained impressed. Years later he wrote to her son Byron: "In the memoir of Mr. Menabrea and still more in the excellent Notes appended by your mother you will find the only comprehensive view of the powers of the Analytical Engine which the mathematicians of the world have yet expressed." Babbage called Ada the "Enchantress of Numbers."

Ada as a Metaphor Today

It is difficult to write anything about Ada today without being aware that her name now adorns a computer language used by the United States Department of Defense to simulate "War Games." George Lakoff in "The Metaphors We Live By" presents an alternative to the myths of objectivity and subjectivity which he calls "imaginative rationality." Ada's called it "Poetical Science." Her Notes reveal the critical skill of integrating poetry and science as opposed to the terminal disease of "tunnel vision," of just a digital view which many people now suffer from.

Because recent books about Ada have conveyed romantic stereotypes her power of thinking has been distorted and obscured. It is difficult for all of us to grasp a mind set that integrates Plato, and Aristotle, the world of poetry and science, but it is Ada's remarkable skill of "poetical science" which enabled to choose an appropriate program to show the power of the Analytical Engine as well as to predict the impact of a technological innovation which had not even been built. This skill is especially critical today in order for all of us to escape the "tunnel vision" of a science which could lead to the vision her father had, in 1816, of the dark end of things:

I had a dream, which was not all a dream.
The bright sun was extinguish'd, and the stars Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air; Morn came and went - and came, and brought no day. (p.20)

Instead Ada had another vision:

> My sun is rising with a clear, steady, & full, rather than dazzlingly brilliant light, and is illuminating all around me. He will I expect gradually run his course, to his zenith, with the same full, steady, even, light; . . . and he will tell me to leave for mankind in my footsteps a little of that brightness from Beyond, which he has reflected on my head, an earnest, an indication, a glimpse of that which the great Future will unroll!– (p.20)

Bibliography:

All quotes come from, and are referred to by page number in the text.

Ada, the Enchantress of Numbers: A Selection from the Letters of Lord Byron's Daughter and her description of the First Computer by Betty Alexandra Toole, Strawberry Press, 1992

Ada, the Enchantress of Numbers: Prophet of the Computer, Betty Alexandra Toole Strawberry Press, 1998

Metaphors We Live By, Geroge Lakoff, University of Chicago Press, 1986