# Ada, An Analyst and a Metaphysician

Betty Alexandra Toole Ed.D.
8 Starboard Court
Mill Valley, California 94941
415-388-3549

**Abstract: Is Ada a fitting name for the software language named after her?**

Today, words, symbols and language are so manipulated that what Darell Huff proclaimed for numbers, "Statistics Don't Lie, But Liars use Statistics", certainly applies to words. Mario Pei, in Words in Sheep's Clothing states that words have come to mean either the opposite of what they originally meant, or something so remote and confusing that one hesitates to use them.

This article will give you a glimmer of the fascinating human story of Ada. Hopefully that glimmer, or biopsy, will not distort but enrich the information available about her life. Human beings are inconsistent, that is both their weakness and their strength. To fashion data about a human being into a consistency, in order to prove a point often makes me suspicious. However, the more I know about Ada, the software language, the more appropriate I believe the name Ada is for the software language. You, as users of Ada, are a better judge of that and I would certainly appreciate your reaction and observations.

The information that I have selected for this article are from the thousands of letters in the Lovelace-Byron Collection at Oxford University, the British Library, and Ada's Notes. The emphasis is on how Ada approached information, mathematics, science and technology. Perhaps, this glimpse of Ada's life and the way she thought, might prompt you to see a connection between Ada's story and the history, structure and implementation of Ada, the software language.

### Poetical Science

I became fascinated by Ada, the human being, when I was writing my doctoral dissertation. A chapter dealt with the history of calculating devices and as part of my research I went to visit the the Science Museum in London. Next to a model of Charles Babbage's Analytical Engine, which is now heralded by many 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. It was the strange combination of poetry and science that 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 separation between these two views, poetry and science, right brain and left brain, or however you would like to characterize it, 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, 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?"[1] Lady Byron never saw the connection.

**The Mathematical Education of Lord Byron's Daughter: Informal and Formal Development**

Mathematical understanding is not reflected just 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. Lady Byron decided that Ada's education would emphasize the "facts" - mathematics.

Though both Dr. Frend (Lady Byron's tutor) and Augusta (Lord Byron's sister) cautioned Lady Byron about putting pressure on Ada, at five years old, to learn from dawn to dusk, Lady Byron proceeded with her "system" of education. Ada was rewarded with "tickets" for doing her lessons well. When Ada did not perform up to Lady Byron's expectations, "tickets" were forfeited and other measures were taken. When Ada remarked that she wished that she could get to "the end of arithmetic", she was reprimanded.

It was on Sundays, when Ada did not have formal classes, that the theories of the Swiss educator, Pestalozzi, were integrated into Ada's education. Pestalozzi was one of the first educators to gear instruction to the level of the child by using concrete objects. Working with blocks, Ada had to form a design. Ada's governess, Miss Lamont, was pleased with how animated Ada became and how she took more pleasure "in imagining for herself as she proceeded" than in being guided by a model. A very astute observation, because Ada followed that pattern throughout her life.

**An Object Oriented Design**

When Ada was twelve years old, this future "Lady Fairy", as Charles Babbage affectionately called her, decided that she wanted to fly. Ada had an object in mind, a flying machine, and proceeded to go about designing it, 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. Her final step was to integrate steam with the "art of flying".

Steam proved to be Ada's most difficult problem to overcome. She developed a design, and she thought that if she was successful her flying machine would be even more "wonderful than steam packets or steam carriages". Her design was to make a "thing in the form of a horse with a steam engine in the inside so . . . as to move an immense pair of wings" and in such a manner "as to carry it up into the air while a person sits on its back."[2]

Ada's ideas predate Henson's design for an Aerial Steam Carriage in 1842. Lady Byron humored Ada's project, but when she learned that Ada was not attending to her studies she was reprimanded. Ada thanked her mother for her "kind advice" and dropped the flying project, but the idea of the potentiality of technology did not escape her imagination.

**Ada as a a Teacher and a Student**

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. A list of his accomplishments fill five pages in Anthony Hyman's biography Charles Babbage, Pioneer of the Computer and Babbage, like Ada, was a master of the metaphor. 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.

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".[3] 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 labelled, 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".

At the same time that Ada was teaching she was also receiving instruction from Dr. King, under the watchful eye of Lady Byron. He freely admitted that Ada surpassed his knowledge. When Ada worried about her imagination running wild, Dr. King 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 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.

**Mathematical Models, Correspondence and Programs**

Ada married in 1835 William Lord King, who became in 1838 the Earl of Lovelace. They had three children before their fourth anniversary, but Ada's interest in mathematics, science and technology continued in an informal manner. Ada continued to see and correspond with Babbage. To Ada, and Babbage, mathematics were not just a serious matter but fun as well.

In 1836, trying not to loose the thread of mathematics, Ada sought wooden mathematical models; spheres and polyhedra to help her understand mathematics. Like Watson and Crick, and computer simulations today, Ada used these mathematical models as a means of enriching her mathematical understanding.

Whether or not Ada should be deemed the "first programmer", as early as 16 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. The word "program" was not used, or even thought of, in the context of how it is used today, however, the method Ada used, however rudimentary, were the first steps along that path. She concluded her letter on 16 February to Babbage:

> I hope you are bearing me in mind, I mean my mathematical interests. You know this is the greatest favour anyone can do me.- Perhaps, none of us can estimate how great. Who can calculate to what it might lead; if we look beyond the present condition especially?-
>
> You know I am by nature a bit of a philosopher, & a very great speculator, so that I look on through a very immeasurable vista, and though I see nothing but vague & cloudy uncertainty in the foreground of our being, yet I fancy I discern a very bright light a good way further on, and this makes me care much less about the cloudiness & indistinctness which is near- Am I too imaginative for you? I think not. . . .[4]

**Ada's Mathematical Competency, Correspondence and Conceptual Understanding: A Scientific Trinity and the Will o' the Whisp**

In the fall of 1840, Ada returned to the formal study of mathematics, after a four year absence, with Augustus De Morgan, a prominent nineteenth-century mathematician. The instruction took place primarily by mail. Ada asked questions when she could not understand the text De Morgan had given her.

And here, I must go off on a tangent, because Ada's expertise in Mathematics has been called into question by Dorothy Stein in Ada, Life and Legacy. Professionally, I am an evaluator of training programs and systems. One of the best biographers, William St Clair, The Godwins and the Shelleys, (Faber and Faber, 1989) has written about, and performs, an evaluation function for the British government. He has lectured on the similarity between what an evaluator, a biographer, and researcher (and most likely users of Ada software) must do to get at the truth. The first step for all of us is to

question the data, the sample, and understand what that sample represents. In Ada's case, the literary remains of her letters to DeMorgan are a skewed sample: they represent what Ada did not know, not what she did know.

DeMorgan was a much better judge than either Ms. Stein, or myself, as to Ada's mathematical competence. He knew the whole story and evaluated Ada's expertise in Mathematics as even higher than Mary Somerville. DeMorgan wrote to Lady Byron: "I feel bound to tell you that the power of thinking on these matters which Lady L.[Lovelace] has always shewn from the beginning of my correspondence with her, has been something so utterly out of the common way for any beginner, man or woman. . . . Had any young beginner, about to go to Cambridge shewn the same power, I should have prophesized first that this aptitude at grasping the strong points and the real difficulties of first principles would have very much lowered his chance of being senior wrangler, secondly that they would have certainly made him an original mathematical investigator, perhaps of first rate eminence."[5]

Ada's approach, her "scientific Trinity", differentiated her from the traditional mathematician: it was open ended and her style was individual. She wrote in a letter to her mother on 6 February 1841:

> . . . I believe myself to possess a most singular combination of qualities exactly fitted to make me pre-eminently a discoverer of the hidden realities of nature. . . .
> Firstly: Owing to some peculiarity in my nervous system, I have perceptions of some things, which no one else has; or at least very few, if any. This faculty may be designated in me as a singular tact, or some might say an intuitive perception of hidden things;- that is things hidden from the eyes, ears & the ordinary senses- This alone would advantage me little, in the discovery line, but there is
> Secondly;- my immense reasoning faculties;
> Thirdly; my concentrative faculty, by which I mean the power not only of throwing my whole energy & existence into whatever I choose, but also bringing to bear on any one subject or idea, a vast apparatus from all sorts of apparently irrelevant & extraneous sources. I can throw rays from every quarter of the universe into one vast form.
>
> Now these powers; (I cannot resist the wickedness of calling them my discovery or scientific Trinity), are a vast apparatus put into my power by Providence; & it rests with me by a proper course during the next 20 years to make the engine what I please. But haste; or a restless ambition, would quite ruin the whole.
>
> My ambition, & I cannot say with any truth, that I feel myself by any means able to banish ambition, must be of the remote kind. And besides it is rather my belief that greatness of the very highest order, is never appreciated here, to the fullest extent, until after the great man's (or woman's) death. My ambition should be rather to be great, than to be thought so. . . .
>
> Meantime my course is so clear & obvious, that it is delightful to think how straight it is. And yet what a mountain I have to climb! . . . [6]

And a mountain she did climb. Within the month, Ada's mother informed her that her father had committed incest with his half-sister Augusta, and fathered a child. Whether or not this allegation was true it brought Ada's studies to a grinding halt for five months.

A few months after she returned to her studies, in October 1841, Dr. John Phillips Kay (later Kay- Shuttleworth), an admirer of

Ada, christened her a "Will o' Whisp". In late November Ada became frustrated with her life, and mathematics. She expressed that frustration mathematically, as she often did.

Ada had difficulty understanding functional equations. She wrote DeMorgan on November 27, most likely 1841: "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."[7]

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.

She let her mathematics instruction drop again for six months or longer and then returned once again to her studies in the summer of 1842. The literary fragments of Ada's correspondence, at this time, 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.

**Did Ada write the Notes?**
**An Analyst and Metaphysician**

I wish I did not have to take the time or space to answer this question, however, some biographers of Ada and Babbage, (and even the description of Ada's contribution to the Notes in the exhibit of part of the Analytical Engine at the Science Museum in London), call into question Ada's contribution to the Notes; almost as if Babbage wrote them and Ada was merely his secretary. I cannot quite understand why that question even arose. Babbage in his autobiography clearly stated that Ada wrote the Notes, based on the material he gave her. Babbage further stated that Ada corrected a mathematical error that he made. I hope the following two excerpts, quite delightful at the very least, will clear up that controversy:

Sunday 30th July [1843]

I am beyond measure vexed to find that instead of inserting my corrected Table in the Revise, they have left it exactly as it was before. Pray see about it immediately. It is exceedingly careless & annoying.

Out of several corrections made, not one is inserted, neither are the Upper Indices added; nor the little Foot-Note. I send you back all the latter part of the Revise, & the corresponding proofs, that you may look to the matter forthwith. I cannot account for such negligence.

I do not think you possess half my forethoughts, & powers of foreseeing all possible contingencies (probable & improbable, just alike).-

I am glad to see the sheets I return so clean on the whole.

Tomorrow I expect to send you up the rest of the Revise, & Note A by my governess, in the middle of the day, & more by post.

I will work most diligently; but I wish to revise the Notes myself. You might send some one down here the moment you get them; & I would attend

immediately & send them back by the same or some other special messenger.-. . . . How very careless of you to forget that Note; & how much waiting on & service you owe me, to compensate.

I am in good spirits; for I hope another year will make me really something of an Analyst. The more I study, the more insatiable do I feel my genius for it to be.

I do not believe that my father was (or ever could have been) such a Poet as I shall be an Analyst, (& Metaphysician); for with me the two go together indissolubly.-[8]

I think the ability to be both an Analyst and Metaphysician is the ability to perform a cosmic dance; of being in the data or program, analyzing it from every angle, and at the same time being above it, objectively skeptical. Ada had those rare skills. She was the perfect person to see the true nature of the Analytical Engine, its power and potential.

There is no question that the the Notes were a collaborative effort, (as most proposals are today), since it was based on Babbage's Analytical Engine, however the actual authorship, its forethoughts and foreseeing, were a result of Ada's talent. The excerpt from the next letter underscores Ada's authorship. It was most likely written on 1 August 1843, Ada's dating of letters at this time was a sometimes thing:

I wish you were as accurate, & as much to be relied on, as I am myself.

You might often save me much trouble, if you were; whereas you in reality add to my trouble not infrequently; and there is at any rate always the anxiety of doubting if you will not get me into a scrape; even when you don't.

By the way, I hope you do not take upon yourself to alter my corrections.

I must beg you not. They all have some very sufficient reason. And you have made a pretty mess & confusion in one or two places (which I will show you sometime), where you have ventured in my M.S.'s, to insert or alter a phrase or word; & have utterly muddled the sense.

I could not conceive at first in one or two places what had happened to my sentences; tho' I soon saw they were patchwork & not my own; and found it so on referring to the M. S. I fear you will think this is a very cross letter. Never mind. I am a good little thing, after all. [9]

If indeed Babbage had written the Notes, a minor edit would not have evoked the kind of anger that Ada expressed.

**The Mystical Lady and the Mystical Machine: The Notes**

From 1841 it was in Ada's mind that in some way she might be of service to Babbage. She wrote on Tuesday 5th January 1841:

What is Imagination? We talk much of Imagination. We talk of the Imagination of Poets, the Imagination of Artists &c; I am inclined to think that in general we don't know very exactly what we are talking about. Imagination I think especially two fold.

First: it is the Combining Faculty. It brings together things, facts, ideas, conceptions, in new, original, endless, ever varying, Combinations. It seizes points in common, between subjects having no apparent connexion, & hence seldom or never brought into juxtaposition.

Secondly: it conceives & brings into mental presence that which is far away, or invisible, or which in short does not exist within our physical & conscious cognizance. Hence is it especially the religious faculty; the ground-work of Faith. It is God-like, a noble faculty. It renders Earth tolerable, (at least it should do so); it teaches us to live, in the tone of the eternal. . . .

> Imagination is the Discovering Faculty, pre-eminently. It is that which penetrates into the unseen worlds around us, the worlds of Science. It is that which feels & discovers what is, the real which we see not, which exists not for our senses. Those who have learned to walk on the threshold of the unknown worlds, by means of what are commonly termed par excellence the exact sciences, may then with the fair white wings of Imagination hope to soar further into the unexplored amidst which we live.
>
> Mathematical Science show what is. It is the language of unseen relations between things. But to use & apply that language we must be able to fully appreciate, to feel, to seize, the unseen, the unconscious. Imagination too shows what is, the is that is beyond the senses. Hence she is or should be especially cultivated by the truly Scientific,- those who wish to enter into the worlds around us![10]

Ada had suggested that imagination was not only useful to poets but to scientists as well. In writing the Notes Ada used her imagination to accomplish the same goal of unifying vision and thought. Though in Ada's translation of Menabrea's description of Babbage's Analytical Engine there is a typographical error (years later corrected by Babbage's son with another error), Ada had no difficulty in describing, in her Notes, both the "unified whole" and the details of Babbage's Analytical Engine; of being both an Analyst & Metaphysician.

Ada approached the Notes, using the same methodology as she approached her designs for a "flying machine ", teaching Lady Gosford's daughters, and her correspondence with De Morgan. She used both "analog" and "digital" skills.

Babbage filled over thirty volumes, by the time he died, with plans for the Analytical Engine. Ada's job was to synthesize and put those ideas together in such a way that the British Government and scientists would recognize the value of Babbage's revolutionary invention.

Babbage differentiated his Analytical Engine from his Difference Engine, by describing it as a machine that not only had foresight but could act on that foresight. Another way of saying it: a mystical machine. Mysticism, and Ada's mysticism, has been used in a pejorative way in Stein's biography. However, in this age of "Chaos", Ada's "mystical ability" is of particular importance in putting technological innovation in a proper context and perspective. In Ada's case, her mysticism was conceptual understanding: she started by asking pertinent questions and selecting a mathematical model that would highlight the difference between Babbage's first calculating engine, the Difference Engine, and the Analytical Engine.

She started the Notes 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.

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: "We may say most aptly, that the Analytical Engine *weaves*

*algebraical patterns* just as the Jacquard-loom weaves flowers and leaves."[11]. 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."[12]

**The Perfect Program and the Potential of the Analytical Engine: The Enchantress of Numbers**

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.

One researcher suggested that Babbage had worked through sample programs and gave a selection of them to Ada to use in her Notes, however Ada had her own ideas. She wrote Babbage, most likely on 10 July 1843:

> My Dear Babbage
>
> I am working very hard for you; like the Devil in fact; (which perhaps I am).
>
> I think you will be pleased. I have made what appears to me some very important extensions & improvements. Why I now write is to beg you will send down to the Square before tomorrow evening Brookes' Formulae & also the Report of the Royal Society on your machine. I suppose you can get it easily, & I particularly want to see it, before I see you on Weddy Morg.
>
> It appears to me that I am working up the Notes with much success; & that even if the book be delayed in its' publication, a week or two in consequence, it would be worth Mr. Taylor's while to wait. I will have it well & fully done; or not at all.
>
> I want to put in something about Bernoulli's Numbers, in one of my Notes, as an example of how an implicit function, may be worked out by the engine, without having been worked out by human head & hands first. Give me the necessary data & formulae.[13]

The Bernoulli numbers was a perfect example to show that difference. In order to calculate Bernoulli numbers you must perform many operations, take the results of those operations, and use them in other operations, for example; add, then divide, then raise to a power and on and on; think of it as a nested design. No mere calculator or calculating engine, like the Difference Engine, could perform this feat, only the Analytical Engine could.

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.

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: I have put in bold type what has often been quoted and today, often debated with great passion. This selection from her Note G, puts her statement in context:

> It is desirable to guard against the possibility of exaggerated ideas that might arise as to the powers of the Analytical Engine. In considering a new subject, there is frequently a tendency, first, to *overrate* what we find to be already interesting or remarkable; and, secondly, by a sort of natural reaction, to *undervalue* the true state of the case,

when we discover that our notions have surpassed those that were really tenable.

**The Analytical Engine has no pretensions whatever to *originate* anything. It can do whatever we *know how to order it* to perform.** It can *follow* analysis; but it has no power of *anticipating* any analytical relations or truths. Its province is to assist us in making *available* what we are already acquainted with. This it is calculated to effect primarily and chiefly of course, through its executive facilities; but it is likely to exert an *indirect* and reciprocal influence on science itself in another manner. For, in so distributing and combining the truths and the formulæ of analysis, that they may become most easily and rapidly amenable to the mechanical combinations of the engine, the relations and the nature of many subjects in that science are necessarily thrown into new lights, and more profoundly investigated. This is a decidedly indirect, and a somewhat *speculative* consequence of such an invention. It is however pretty evident, on general principles, that in devising for mathematical truths a new form in which to record and throw themselves out for actual use, views are likely to be induced which should again react on the more theoretical phase of the subject. There are in all extensions of human power, or additions to human knowledge, various *collateral* influences, beside the main and primary objects attained. [14]

**Ada as a General**

When Ada and Babbage were working on the Notes, Lord Lovelace was impressed with Ada's determination and her ability to handle the many variables. Perhaps, he remembered the Duke of Wellington's response in examining Babbage's first engine, and its ability to handle the many variables that a General had and has to handle.

Ada wrote Babbage:

"Lord L[Lovelace],- sometimes says "what a General you would make!" Fancy me in times of social & political trouble, (had worldly power, rule, & ambition been my line, which it could never be)-

A desperate spirit truly; & with a degree of deep & fathomless prudence, which is strangely at variance with the daring & the enterprise of the character, a union that would give me unlimited sway & success, in all probability.

My Kingdom is not to be a temporal one, thank Heaven!-".

Ada concluded this letter: "it is perhaps well for the world that my line & ambition is over the spiritual; & that I have not taken it into my head, or lived in times & circumstances calculated to put it into my head, to deal with the sword, poison, & intrigue, in the place of x, y, & z."[15]

This teasing and cajoling characterized Ada's correspondence with Babbage. Ada felt that she was "flying" and Babbage responded by calling her "Lady Fairy". However, 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."[16] Babbage called Ada, the "Enchantress of Numbers".

**Conclusion: 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 developed by the United States Department of Defense. Is Ada the appropriate name for the computer language?

George Lakoff in The Metaphors We Live By presents an alternative to the myths of objectivity and subjectivity which he calls

"imaginative rationality". The computer language, Ada, according to Robert DaCosta's article in *Defense Science*, April, 1984, was developed, at first, informally. It appears to me from preliminary discussions with people who use Ada, that the greatest attributes of the language are its expressive power, which derives from its metaphysical strength, and simultaneously, its discipline, which derives from its analytical ability. These strengths, when integrated, are unique in a computer language and are similar or isomorphic characteristics to Ada's approach to mathematical and scientific understanding: she was an analyst and a metaphysician.

In the light of the interaction between computer and nuclear power, our computer languages need to have the structure, like Ada, to allow us to be both analyst and metaphysician. As a result I believe Ada is an appropriate trademark or symbol of the United States Department of Defense. Her Notes, and the computer language, reveal the critical skill of "imaginative rationality", as opposed to the terminal disease of "tunnel vision", which many computer software programs and people now suffer from.

Some predictions are based on conceptual understanding and some are just chance, but in the last year of Ada's life she wrote what she thought was her destiny:

> 29th Oct[r] [1851]
>
> . . . If I could ever help to give the despots a shove, I should certainly feel that I had not lived in vain. -
>
> Your hope and expectation almost, that such a day may arrive, gives me great encouragement.
>
> I think when you do bye and bye, see certain productions, you will not even despair of my being in time an Autocrat, in my own way; before whose marshalled regiments some of the iron rulers of the earth may even have to give way !-
>
> But of what materials my regiments are to consist, I do not at present divulge. I have however the hope that they will be most harmoniously disciplined troops; - consisting of vast numbers & marching in irresistible power to the sound of Music. Is this not very mysterious? Certainly my troops must consist of numbers, or they can have no existence at all, & would cease to be the particular sort of troops in question.- But then what are these numbers ? There is a riddle.[17]

Ada's remarkable skill of "imaginative rationality", of being an analyst and a metaphysician, which enabled her to predict the impact of a technological innovation is especially critical today in order for all of us to escape the "tunnel vision" of a language or 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.[18]

**Acknowledgements /Bibliography and Footnotes**

The Earl of Lytton kindly granted permission to read and quote from the Lovelace- Byron papers. Malcolm Elwin was the first biographer who was given access to the Lovelace-Byron papers which he started to catalogue. That cataloguing was expertly completed by Mary Clapinson (now keeper of Western Manuscripts) when the collection was deposited at the Bodleian Library at Oxford University. Malcolm Elwin complained that authors did not give credit when citing from his biographies, citing

instead the Lovelace-Byron papers. Unfortunately that holds true with reference to Ada, as well, therefore I am just citing Lovelace-Byron papers, and not the actual box number. That is easily attained by scholars. The British Library no longer requires precise acknowledgement. All of the letters from Ada to Babbage are in that collection, and easily found in the catalogue at the British Library. When quoting from Ada's Notes, I will just cite Scientific Memoirs and the page. Her translation and Notes are found in Richard Taylor, ed., Scientific Memoirs, Volume III, London John E. Taylor, 1843 p. 666-731 Article XXIX, "Sketch of the Analytical Engine invented by Charles Babbage Esq, by L.F. Menabrea, of Turin, Officer of the Military Engineers [From the Bibliothèque que Universelle de Génève, No.82 October 1842].

**The following books and articles have been referred to in this article:**

Hyman, Anthony. Charles Babbage, Pioneer of the Computer. (Oxford, 1984).

Lakoff, George, and Johnson, Mark. The Metaphors We Live By. (University of Chicago, 1980).

Pei, Mario. Words in Sheep's Clothing. (Hawthorn Books, Inc, 1969).

Stein, Dorothy. Ada, a Life and Legacy. (MIT, 1985)

*Defense Science and Electronics*, March 1984, *The History of Ada*, by Robert DaCosta.

**Footnotes:**

[1] Lovelace-Byron

[2] Lovelace-Byron

[3] Lovelace-Byron

[4] British Library

[5] Lovelace-Byron

[6] Lovelace- Byron

[7] Lovelace Byron* Ada spelled Whisp without an "h". The dating on this letter is critical in that Ms. Stein uses this letter as evidence that Ada did not understand mathematics. There is no year on this letter, despite Ms. Stein putting in 1842. The probability is much higher that it was written in 1841, not 1842, as it is part of series of letters from Ashley Combe, Ada's Somerset home.

[8] British Library

[9] British Library

[10] Lovelace-Byron

[11] Scientific Memoir p.696

[12] Op. Cit p.694

[13] British Library

[14] Scientific Memoir p. 722

[15] Lovelace- Byron

[16] British Library

[17] Lovelace- Byron

[18] Byron's Works, (London, John Murray 1852), p.563. An excerpt from the poem *Darkness* which was written at Diodati, the summer of 1816, when Mary Shelley conceived Frankenstein. The poem was originally entitled *The Dream.* Sir Walter Scott's annotation of this poem in my edition of Byron's work is illuminating: "In this poem Lord Byron has abandoned the art, so peculiarly his own of showing the reader where his purpose tends, and has contented himself with presenting a mass of powerful ideas, unarranged, and the meaning of which it is not easy to attain. . . To speak plainly, the framing of such phantasms is a dangerous employment for the exalted and teeming imagination of such a poet as Lord Byron, whose Pegasus ever required a bridle than a spur." Yet, this poem, at least to me, has even more power and meaning today than the day it was written.