Buckinghamshire New University

Picturing Lovelace, Babbage, and the Analytical Engine: a cartoonist in mathematical biography

Sydney Padua

The story of how Charles Babbage, Lucasian Professor of Mathematics, poly-math, and tinkerer, almost invented the computer in the 1830s has long been an opening parable in computer science textbooks. The murkier but irresistible subplot that he was assisted by so dramatic a figure as the estranged daughter of Lord Byron has taken this cul-de-sac of history into the realm of myth. Babbage, Lovelace, and the unrealised calculating engines fuel an industry of steampunk fantasies, one of which was my graphic novel, *The Thrilling Adventures of Lovelace and Babbage*, so kindly honoured by the BSHM with the Neumann Prize in 2015.

As a non-academic, non-mathematician, non-historian, non-computer scientist, non-everything that would be useful to the writing of a mathematical biography, writing a paper for this publication has been a nerve-wracking experience. What I am is an animator, a species not often asked to write anything, though I suppose the animator does have a little in common with the biographer - we are trying to create an illusion of life from bits of dead paper. Unlike the biographer, the cartoonist can't make any pretence to objectivity - when you draw someone you are trying to get, in an almost literal way, under their skin. My job involves studying the anatomy of a character, trying to understand the forces that push, pull, and distort shapes, and transform those shapes into a semblance of thinking and feeling beings, or at least to exaggerate them, make them funny. I was pleased to see my stock-in-trade recently called by Richard Holmes 'the biographer's most valuable but perilous weapon: empathy'.

I ought to say that although I set out to write about how I approached turning this subject into a comic book, I didn't so much approach the subject as I was ambushed by it. *Lovelace and Babbage* began as a very brief comic-strip biography drawn in an evening for the first Ada Lovelace Day in 2009. The extent of my research was a bit of browsing on Wikipedia. When my little comic attracted an unexpected amount of attention and an expectation of more, I started a blog with no higher ambition than sketching the occasional Asterix-style squiblet for my own amusement.

It would certainly have never been anything else had it not been for the launch of the Google Books project, which was in its infancy when I started posting comics. I first turned to Google Books out of mild curiosity to read Babbage's autobiography. That marvellous book, *Passages from the life of a philosopher*, was what transformed a brief flirtation into a full-blown obsession. It was full of volcanoes, jokes, rants, mad inventions, and above all a spectacular main character, material for dozens of comic books. It was a character irresistible to the cartoonist, direct and full of energy, and the webcomic owed its existence to my inability to stop doodling Babbage in various attitudes. Later, when I started collecting contemporary reviews of *Passages*, I could fully concur with *The Saturday Review*'s assessment of it as 'a mine of suggestion, even if it were not one of the strangest and most amusing books a man ever wrote about himself'. Having lit the fuse, Google Books provided heaps of fuel. Simply by being (as far as I can tell) the first person to put the terms 'Lovelace' and 'Babbage' into the search box and pointing it at the great heap of Victorian publications, I pulled up netfulls of documents,[1] still wriggling with life.

---

[1] For those wishing to explore, most of them, with my annotations, can be found here: https://www.diigo.com/outliner/4232ob/Lovelace-and-Babbage–Period-Documents. I caveat that many of the Google Books scans are unfortunate victims to copyright claims which have broken some of my links, despite clearly being in the public domain.

Figure 1. Babbage body language studies (copyright the author)

Babbage's personality in the *Passages* is so vivid and extravagantly idiosyncratic that coming across him in a Victorian article was like finding a primary source featuring Ebenezer Scrooge or the White Rabbit. Anecdotes abounded about the 'celebrated Mr. Babbage', or as the *Literary Gazette* called him in 1832, the 'logarithmetical Frankenstein'. Having met Babbage in his own book one need hardly be told that 'his whole expression was energetic', that he spoke with a 'ready click', that if you went out for dinner with him (as almost every notable person of the age seems to have done), you should be prepared for a long night: 'it was with the greatest difficulty that I escaped from him at two in the morning, after a most delightful evening'. Whether he is aweing an admiring visitor by being 'by turns playful, profound, practical, always enthusiastic', or 'making a great fool of himself, as he does everywhere', Babbage is always 'in character'.

Ada, Countess of Lovelace was another story. Closed, twisty, and ambiguous where Babbage was everything open, direct, consistent, Lovelace's image began to shift and fall apart as soon as I tried to look at her directly. Anyone who has had the experience of hacking through the thicket of truth, myth, hyperbole, supposition, assertion, and counter-assertion that is Ada Lovelace will I hope sympathize with my state of shock when I first stepped behind her tidy role-model facade. According to some scholarship Lovelace was no genius or even a mathematician, just a fancy name for Babbage to cynically use. Or was she an unfairly over-scrutinized target of misogynists? Ada felt horribly like she could at any moment be exposed as that most haunting spectre to any woman in a technical field: a fraud. What business had a very un-mathematical cartoonist to step into this minefield? Though I never wrote about it publicly, what was meant to be a fun hobby was pervaded by the feeling of holding an unexploded bomb. But still I couldn't seem to stop drawing comics, trying to feel out with jokes and drawings who this person had been.

Figure 2. Ada, pursued by an asterisk (courtesy of Particular Books)
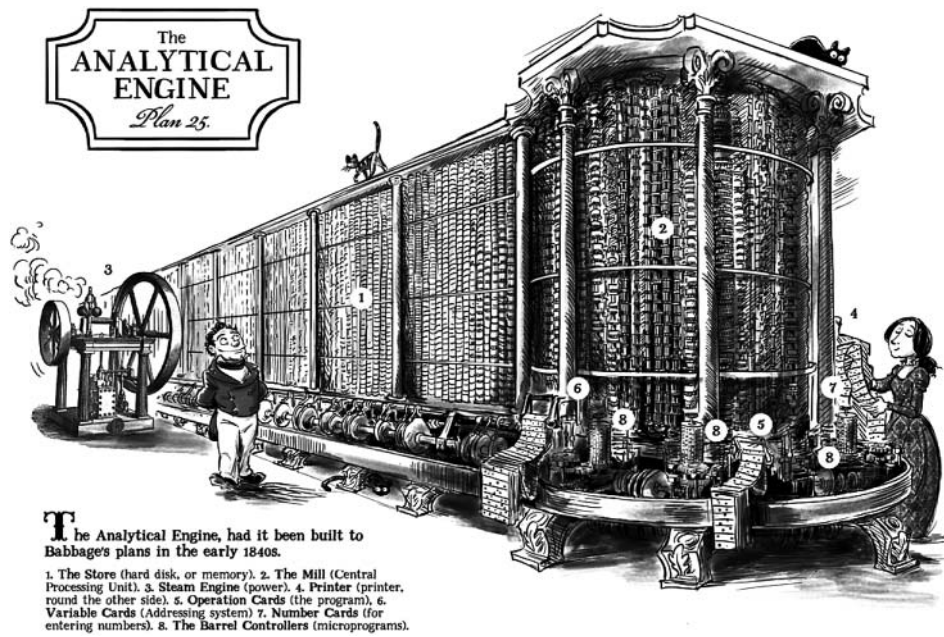

Figure 3. The Analytical Engine (courtesy of Particular Books)

Google Books at first offered no comfort. While Babbage seemed ubiquitous in early Victorian London and every document I found reinforced my image of him, Ada only showed up in brief, rare glimpses, few giving any impression of her as a person, and all of which contradicted each other. She strongly resembled Lord Byron, she didn't bear the least resemblance. She was 'buoyant and hearty' or silent and withdrawn. She was ladylike and sensible or peculiar and inappropriate. The only points of agreement on the sort of anecdotal sources on Google Books were that she was tall, not beautiful (an assessment of her looks was a required note in the briefest of mentions), and oddly dressed. Personality there is certainly to be found in her letters, collected and transcribed by Betty A Toole in *Ada: enchantress of numbers*, but those provided a dozen personalities rather than one - Ada seemed to adopt a different character for every person she wrote to and every day of the week (not for nothing is she often speculated to have had a bipolar disorder). 'She had indeed a most variable personality' her first biographer Doris Langley Moore wrote in some exasperation, and it's only fitting that her many biographies all seem to be written about entirely different people. For a cartoonist in need of a simple, clear caricature she was slippery ground. I drew her from where I felt she was most herself: in her flurry of correspondence with Babbage. There she was arrogant, funny, exasperated, playful, weird; not clearly a 'genius', perhaps, but someone Babbage, a man not notable for dissembling, was addressing with confidence and respect.

That Lovelace and Babbage's friendship was a deep and sincere one, was the one impression I had from their correspondence that I was ready to fight for, and the Victorians seemed to agree. They appear together frequently in anecdote, where they are 'the best of friends', and many report that 'Babbage loved to talk of her'. My greatest coup, for which I can claim no more credit than chance, was the magical find of the holy grail of scholars, an undiscovered letter in an obscure journal. At the time Google was continually adding new scans to their archive, and I still had a weekly thrill of a new search result. *The Southern Review*, a peculiar publication from the aftermath of the Civil War, for some reason printed a lengthy and decade-old letter by the poet Henry Reed, which featured a meeting with Babbage in 1854. I almost wept with relief at this vivid account of Babbage's emotion recalling Ada's death, of his eagerness to talk about her and her mathematical ability, and wonderfully, of her 'peculiar capability, higher he said than that of anyone he knew, to prepare the descriptions connected to his calculating machines'. Not an ironclad proof, perhaps, of my favoured Ada, but a rod and comfort to me nonetheless.

Finally, there is a third essential character to the story: the marvellous, mysterious Analytical Engine. Like Babbage and Lovelace, the Engine's incarnation in the comic universe is a fantasy of impressions - of computing (mysterious, labyrinthine, full of traps for the unwary), of steampunk (cogwheels, steam, pipes), of Victorian engineering (big, curlicued, covered in grime). Most of the comic takes place in and around the Engine, a terrific setting and inexhaustible source of plots and dramatic vistas. But although I spent years combing over every scrap I came across about the human leads, I confess that as long as I was drawing the comic for my own amusement I was content with the barest superficial understanding of the Engine itself. When putting together the material for a book however I had to knuckle down; the entire heavily footnoted and primary-sourced graphic novel revolved around the Analytical Engine, so it seemed impossible not to include a visualization of the actual machine and an explanation of its workings. I knew only that it was physically large, metallic, and that there were punchcards around it somewhere. I have no background or qualifications in mechanical engineering, but as an animator I'm at least used to understanding the anatomy of strange creatures, so I scheduled myself two weeks to sit down with the ubiquitous lollypop-shaped diagram that illustrated articles on Babbage, and produce from it a nice two-page spread depicting the Analytical Engine as it would have been. It took nearly five months.

Babbage himself, in his few and scattered published pieces on the Engine, describes it in charming but vague personifications (the Engine 'demands', 'foresees', 'is hungry for') and the Lovelace paper, for all its detailed mathematics, describes a machine as abstract as Turing's. To my extreme dismay I found that this nebulousness of both appearance and practical operation extended to nearly every source on the Analytical Engine, either historic or contemporary. I could find no clear description of the 'ingenious mechanisms' that were alluded to but never described. Babbage's calculating machines - the distinction between the Difference and Analytical Engines was as fudged by commentators then as now - had a large presence in the Victorian imagination, from Oliver Wendell Holmes ('what a satire is that machine on the mere mathematician! A Frankenstein-monster, a thing without bargains and without heart, too stupid to make blunder') to Sherlock Holmes ('Holmes is as inhuman as Babbage's Calculating Machine, and just about as likely to fall in love'), but there was almost no imagery associated with them. The few exceptions I could find were comical ones: I was both delighted and unnerved by a 1851 flight of fancy in *Blackwood's Magazine*, picturing the Analytical Engine as vast 'infinitesimal' corridors of cogwheels, presided over by an indomitable Babbage, and subject to comical crashes and bad puns, exactly as I had done in the comic! Mostly the Analytical Engine was an exemplar of the complex fringes of science, and it was taken for granted that the machine's workings were incomprehensible to any ordinary person.

Contemporary sources to my surprise were little better, at least from the point of view of the cartoonist - it was easy to find descriptions of the history and abstract functions of the Analytical Engine, but little that helped to materialize it as a physical object. Fortunately I was eventually led to the publications of the late Alan Bromley in the *Annals of the History of Computing*, or I could have gone no further. In a series of papers in the 1980s Bromley at last went into some detail on some of the mechanics, though he had only a handful of illustrations of small parts, and I was still in the dark about such basic questions as where to draw the punchcards. It was impossible to make any kind of coherent model without having a better idea of how the parts were meant to work together. I turned to the three-dimensional graphics tool I used in film animation work, AliasWavefront Maya. My process was generally to start with whatever plans I could lay my hands on - there were a few dozen reproductions, in fuzzy mimeographs, in various journals and online - bring them into Maya, and from them block out whatever was immediately clear - which was seldom much, as Babbage includes few elevations in his plans. I read over Bromley's description of what was meant to be happening, then tried to tweak and arrange my model in motion until it seemed to be able to accomplish what was required. I soon found out why no one seemed to have attempted a visualization of the whole machine: the plans were far more ambiguous than they looked. Plan 25 arranges drawings of the card spindles around the edges of the main plan, but once I started modelling them they seemed awfully big, far bigger than the sample cards I had seen at the Science Museum. Were they drawn to a different scale than the rest of the machine? Was there even a relationship to their location on the plan and where they would actually be? The absence of an elevation compounded the mysteries. I had pictured the cards at the top of the machine, like a Jacquard Loom, but had to revise them down to the bottom, closer to the cams they would be driving. The cams themselves I had to take an awkward stab at inventing, as no driving mechanisms appear in the plans. My computer's memory was soon as littered with half-built mechanisms as Babbage's famously cluttered workrooms, but I was eventually able to produce the image I needed and feel that it was, at least, not *entirely* wrong.[2]

It was a project for which I was entirely unqualified. On the other hand, my ignorance allowed me to come at the problem of working out the calculating machine from the same direction as

---

[2] Much like Babbage did, I found it difficult to convey the Engine's operation in still images. Babbage devised a mechanical language for the purpose; I found the most effective way to explain it to be animation. Several videos explaining functions of the machine can be found at youtube.com/sydneypadua.

Babbage and Lovelace did: untainted by any preconceived notion of how a computer worked. And compared to the fraught ambiguities of Lovelace, reconstructing the Analytical Engine was as satisfying and almost relaxing puzzle. What a mechanical calculating machine looks like and how it moves, however elaborate, is something that can be figured out with considerably more certainty and consensus than what long-dead human beings look like and how they moved. But the process of the Analytical Engine gave me, unexpectedly, a new insight into my human subjects. As the intricacy of the designs became clearer to me, the scope of Babbage's genius became something I experienced rather than took on authority. His personality also expresses itself in the designs in ways I couldn't have imagined: his obsession with speed, the exactitude of his thinking, and the quirkiness of his Heath-Robinson solutions to problems was all of piece with the man I felt I knew. Something else was clarified for me: it gave me a new respect, even awe, for Lovelace's vision. If one thing was clear, it was that every single aspect of the machine was designed by Babbage with a single end in mind: arithmetic with very large numbers. I had heard many computer scientists waxing lyrical about 'Lovelace's leap': her passionately argued contention that the machine was not bound to arithmetical operations, but could be adapted to manipulate any kind of information. Before the Analytical Engine became familiar to me this insight seemed a thin, abstract one, a lightweight sop. Now, her ability to see in plans for masses of number-crunching metal a device for composing music seems astonishing and beautiful.

Being myself an interloper into these high academic and mathematical matters, I expect much of my anxiety about Ada was rooted in my own self-reflections. A spectral battalion of Real Scholars ready to leap out and expose my fraudulence tormented me, driving me to make more accurate diagrams, find more unassailable documents. Little did I suspect that scholars with a detailed knowledge of Babbage and his engines were a handful of people, and that they would be delightful, helpful, and pleased as punch with Babbage doodles and engine animations! In a small way, I hope I've provided an illustration of the value of a person with an imagination, an obsession, and too much time on their hands, even if they aren't a proper mathematician. I'd like to express my gratitude for the great kindness and support I've encountered from everyone in the community I've met through my work on this subject.