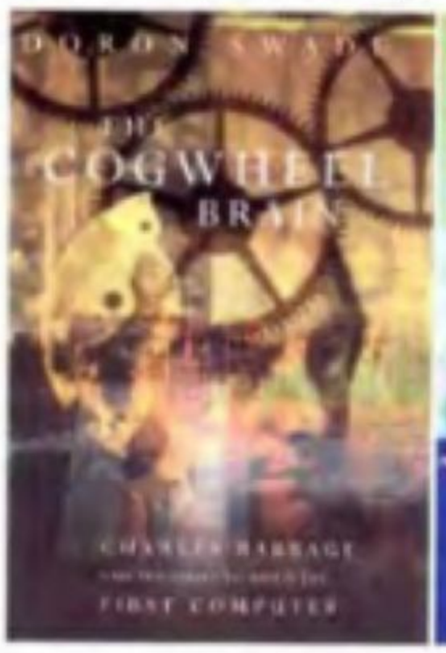
The evolution of intelligent computers.

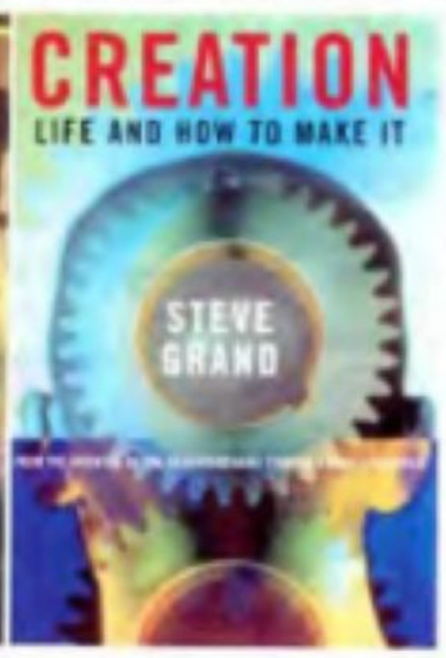
The Cogwheel Brain: Charles Babbage and the Quest to Build the First Computer
By Doron Swade
352 pages, Little, Brown and Company, £15 (available only in the United Kingdom)

Creation: Life and How to Make It
By Steve Grand
240 pages, Weidenfeld & Nicolson, £19 (available only in the United Kingdom)

IN 1834, THE BRITISH mathematician and inventor Charles Babbage leapt beyond his earlier design for a mechanical calculator, called the Difference Engine, by working out the logical architecture for its steam-powered successor, the Analytical Engine. It was the first plan for a general-purpose computer.

Babbage's design was programmable by punched cards, with capabilities like looping (repeating a sequence of operations a predetermined number of times) and branching ("choosing" between alternatives, depending on a calculation's results). Simultaneously, the Analytical Engine's "store" would hold numbers and intermediate results separately from its "mill," where processing would take place. This work prefigured by more than a century the separation of memory and central processor that John Louis von Neumann promoted in 1945 and that has been incorporated into almost all modern machines.





Yet, although Babbage spent the remaining 37 of his 80 years of life working on the Analytical Engine and on a design for Difference Engine No. 2, he never *completed* either machine. Even Difference Engine No. 1 remained only one-seventh finished. With hindsight, we might easily infer that a true computer couldn't really have been constructed out of all those primitive cam plates, cranks, and cogwheels.

Not so. Doron Swade's *The Cogwheel Brain: Charles Babbage and the Quest to Build the First Computer*, besides being a fine biography, records how the author, as curator of computing at London's Science Museum, in 1991 led a project to construct a working Difference Engine No. 2 for the 200th anniversary of Babbage's birth. Babbage's machines could have been built, Mr. Swade concludes, though manufacturing their parts would have been a nontrivial task in an era when production techniques were moving from craft traditions to mass production. For further proof, he cites the Scheutz brothers in Stockholm, who read about the "calculating engine" in 1834 and finished a functioning machine by 1853 for a fraction of what Babbage spent on his uncompleted colossus. Of course, lacking the great man's private fortune and the sums he'd inveigled from the British government, the brothers achieved only bankruptcy as they, like Babbage, discovered that their era had no great interest in calculating engines.

Freud's comment about Leonardo da Vinci can also be applied to Babbage: he was like a man who awoke in the middle of the night when all the rest of the world was still asleep. Unfortunately, Babbage also resembled da Vinci in that he had problems finishing projects because amid each one he'd be seized by a vision of how much more refined the next could be.

Steve Grand, currently, is an interesting case. Here's this guy in England, without academic credentials, who starts programming in 1977. After his son is born, he plays househusband whilst puttering with neural networks and evolved finite-state automata. By 1992 he's sure enough about his ideas that he begins writing a computer game called Creatures, featuring artificial life forms. Creatures becomes massively popular, and Sony buys his company. Now, having been awarded an Order of the British Empire for his work in simulating evolution and life processes within computer environments, Mr. Grand has received funding to research military applications.

In *Creation: Life and How to Make It*, Mr. Grand observes that our bodies' cells replace themselves every seven years, making each of us the corporate enterprise of generations of microbes. He notes that we, like clouds, embody patterns that persist over time while remaining in flux. Indeed, the universe, Mr. Grand points out—from light and other subatomic particles to genes and minds—is nothing but variously self-maintaining patterns.

Mr. Grand believes, paradoxically, that while computer simulations of nerve cells are not real neurons, higher levels of patterns arising from such simulations can be considered brains. Maybe, by simplifying this small fraction of *Creation*'s argument, I'm giving the impression that the author tends toward fuzzy mysticism. Nothing is further from the truth. Mr. Grand is unpretentiously straightforward and lucid—deceptively so, perhaps, since the ramifications of his ideas are sometimes profound. *Creation* is a book to read more than once.

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