Who Was Charles Babbage?

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The Cogwheel Brain
by Doron Swade
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The specific merit in Doron Swade's new assessment of Charles Babbage's role in the development of modern mathematical computing machines, lies in Swade's notable part in the actual construction of a machine according to Babbage's own designs. Swade describes the circumstances leading into the first public demonstration, which was made in London, on Friday, November 29, 1991, three days after inventor Babbage's 200th birthday.

On background, Swade reports: "Charles Babbage came into my life in May 1985 when I was appointed curator of computing at the Science Museum in London." He describes his own role, in that capacity, leading to the launching of the project culminating in both the 1991 public demonstration, and the writing of his biographical account of Babbage's role in this particular matter. He describes the collection of calculating machines which that appointment placed into his custody. So, he encountered Charles Babbage:

> ". . . there was an incomparable prize which stood apart from everything else. This was the largest collection of physical relics of Babbage's efforts to construct his vast and intricate machines. This collection of trophies, all on public display, includes the experimental assembly of the Analytical Engine that was under construction at the time of Babbage's death, all he ever built of that revolutionary machine. Its modest size gives little clue to the monumental intellectual accomplishment of its conception and its much publicized role as the symbolic antecedent of the modern computer."

That part of Swade's account, covering the period from the launching of the Science Museum's Babbage project, from May 20, 1985 through the public demonstration of November 29, 1991, occupies the concluding, third section of his book, which is subtitled: "A Modern Sequel." For qualified specialists familiar with earlier standard sources on Babbage's life and work, the useful contribution of Swade's book, lies almost entirely in the content of that third section.

The misleading elements in the earlier part of Swade's book as a whole, lie in his fallacy of composition. Instead of proceeding from what Babbage represented in science, from his days at Cambridge, on, Swade pushes those issues to the side. He attempts to explain Babbage as a whole, from a narrower standpoint of the computing-machine projects as such, rather than defining the computing-machine projects from the standpoint of the issues of the collaboration with Herschel, the issues which made Babbage the target of an enraged English academic establishment at that time.

Swade pushes aside the matters which he declines to examine; as a result, Swade presents a systemic misrepresentation of Babbage's significance as among the central figures of the early Nineteenth-Century internal history of science in England. Babbage was not the principal hero of British science as a whole, during the period of the adult life of astronomer John Herschel, but is among the leading such figures.

Babbage, for a time, played a leading political role in shaping the history of British science. This began during his student days at Cambridge, and continued for a few decades after that. Notable, on this account, is Swade's misreading of the related political issues of British science and economic policy during the period from the Congress of Vienna to the early days of the British Association for the Advancement of Science (BAAS). It is in the last section of the book, after Swade has dropped further attempt to interpret the issues reflecting that early Nineteenth-Century controversy and its aftermath, that he is able to attack the more narrowly specialized area of his account in a clear-headed and relatively faultless way.

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The issues posed by that, Swade's fallacy of composition, are by no means merely academic ones; but, are, again, today, a life and death issue for the economy of the United Kingdom. The implications of the peril to one of the U.K.'s last remaining keystone industries, Rover, is one which Charles Babbage, in his time would have taken up most heartily. Would the threatened death of imperilled Rover mean, today, the end of technological competence in the U.K.? That same kind of strategic issue was posed in a somewhat different, but not dissimilar historical setting, during the first years of John Herschel's and Babbage's youthful collaboration on related issues of science.

To be fair, in the Preface to the book, Swade did forewarn the reader of the crucial element of risk in his undertaking an appreciation of a subject-matter as historically and scientifically sophisticated as Babbage's life and work actually represents.

> "At that time [May 1985] I was an electronics engineer on the [Science] Museum's staff, designing interactive computer-based displays for the galleries which occupy some seven acres of public exhibition space. Engineers and scientists are trained largely without the civilising influences of history or philosophy, and I was no exception. The two years I spent at Cambridge in the early 1970s was a rewarding counterbalance, though it brought me no closer to the nineteenth century, to Babbage or to his work."

Although I see no specific harm done, within Swade's, somewhat oversimplified, concluding appreciation of Babbage's contributions to the development of modern computing machine, he does miss the key point about the history of computing machinery considered as a whole. The tulip-bubble-style catastrophe now in progress within the financially bloated speculation in "information economy" stockholdings, should provide Swade the opportunity to devote his next book on computing machinery, to such relevant matters which he overlooked in the present one.

I now summarize that case, for those readers who, like Swade, might benefit from my summary reminders on these matters of the history of science and economy.

Swade should have taken the first development of a modern computing machine, by Johannes Kepler, as his point of departure for locating the significance of the collaboration of Babbage and fellow-student John Herschel. As Kepler emphasizes, in his ***The New Astronomy,*** in his attack on the lack of competence of the theoretical side of the work of Claudius Ptolemy, Copernicus, and Tycho Brahe, it was the practical problems posed by the study of the implications of the elliptical orbit of Mars, which continued to supply the impetus for the development of computing machinery, from Kepler, through Pascal, Leibniz, and the circles of such collaborators of Gauss as England's William and John Herschel.

There is nothing in Swade's book which reflects the titanic quarrel over both scientific method in general, and mathematics in particular, which enveloped, and was expressed by young Herschel's and Babbage's devastating, pro-Leibniz attack on the mind-dulling methods of Isaac Newton, during their attendance at Cambridge.

To understand with even minimal competence, the problems and related controversies surrounding the development and applications of modern computing machinery, it is indispensable to start from the most essential controversy within modern physical science. That issue is: whether physical science should be appreciated from the standpoint of the "ivory tower" outlook typified by such empiricist followers of neo-Ockhamite Paolo Sarpi, as both Bertrand Russell and such among Russell's devotees as Norbert Wiener and John von Neumann, or from the contrary standpoint, of viewing mathematics as rooted in, and to be understood from the standpoint of experimental physics?

From the beginning of the development of modern computing machines, this was the crucially underlying issue to be addressed. This begins with the Kepler machine reconstructed by Pascal, and the revolutionary advances contributed by Leibniz, the last respecting both the principles of construction and application of computing machines, and the nature and function of binary numbers.

There are some secondary features of the history of computing machines, which admittedly do not involve that issue of scientific method. Nonetheless, the point may be fairly put, that, in the broad sweep of the matter, a modern secondary and university instruction, both in law and economics, as in mathematics and physical science, seems to prefer to promote the obsession, that the function of mathematics is to degrade physical science to a mere describing of nature, that according to the modern positivist's ivory-tower geometries, or digital-keyboard algebras, rather than the contrary view, of learning the universal principles we have yet to discover at the present boundaries of experimental physical science. It is only from the contrary standpoint of such opponents of ivory-tower formalism as Kepler, Leibniz, Kästner, Gauss, and Riemann, that the crucial issues for the continuing development of computing machines can be properly appreciated.

The latter standpoint, was that of modern science, from Nicholas of Cusa's seminal ***De docta ignorantia,*** through Cusa's self-proclaimed followers Luca Pacioli, Leonardo da Vinci, and Kepler, and, after Kepler, of Pascal, Huyghens, Leibniz, Gauss's teacher Abraham Kästner, Gauss, Wilhelm Weber, and Riemann. It is the bottomless font of formal anomalies, which experimental physics repeatedly forces upon the attention of pre-existing mathematical assumptions, which is the key to the modern history of computing machines since Kepler. This was the point of view of Kepler's founding of modern astronomy, the point of view emphasized by the crucial work of Fermat, of Pascal, Huyghens, Leibniz, and, most emphatically the Herschels' contemporary Gauss.

Gauss's solution for the orbit of the asteroid Ceres, Gauss's related development of geodesy, and Gauss's famous essay on the principles of curved surfaces, typify the kinds of issues which occupied the attention of Babbage and John Herschel. As Gauss's Ceres project typifies the case: *How, from measuring relatively tiny samples of action within a regular system, can we adduce the measurably characteristic action which defines the curvature of that system as a whole?* Riemann's 1954 habilitation dissertation summarizes and typifies the work of Gauss and Gauss's predecessors to this effect.

From that standpoint, modern mathematical physical science, has but begun to scratch the surface, both in discovery of new physical principles, and in the revolutionary changes which those discoveries will impose upon the continued revolutionary transformations in the proper, current definition of the principles of mathematics itself. From this, flows the endless task of freshly redefining mathematics: not only with increasing precision in experimental measurements, but also in entirely new kinds of non-linear methods. There, we meet the crucial function which the continued, revolutionary development of computing machinery must contribute to the progress of civilization.

Babbage, especially in his collaboration with John Herschel, reflected their shared, accurate, and openly expressed concern, that, at that time, the United Kingdom was being left strategically behind both continental Europe and the United States, by the progress of science and mathematics in those latter nations, which was ongoing during the early Nineteenth Century. This is where Swade's book has missed the point. Two paragraphs from early pages of his book, brought together, demonstrate that point.

Science in Post-Vienna-Congress England

It is most notable, that, nowhere does Swade take up the content of the way in which the Cambridge "manifesto" of Herschel's and Babbage's Cambridge book, on the subject of "D-ism and Dot-age," shook up the academic life of England at that time. Instead, Swade makes an oblique, tendentious, and extremely misleading reference to the interest of Babbage and Herschel in the developments within France's Ecole Polytechnique at that time. I begin with quoting two successive paragraphs, from Swade's opening chapter in full, and then juxtapose that to most of a paragraph from earlier in the same chapter. Both must be cited in full to present the issue fairly.

> "Babbage's interest in mathematics was evident early on. He entered Trinity College, Cambridge, in April 1810, aged eighteen, already a precociously accomplished mathematician, and as a new undergraduate he looked forward to having his curiosity and mathematical puzzlement illuminated by his tutors. To his disappointment he found his teachers a staid lot, stuck in an unchanging curriculum and uninterested in the new Continental theories which excited him. Disaffected, independent-minded and even rebellious, he pursued a programme of study of his own which favoured the work of French mathematicians. Babbage was a radical: he admired Napoleonic France (with which Britain was at war), decried the unquestioned acceptance of religious doctrine reflected in the inflexible regulation of university life by the Church [of England], and lamented the stagnant state of mathematics in England. Active and spirited, he became one of the instigators of the Analytical Society, which was dedicated to reform of English mathematics.
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> "At Cambridge he enjoyed student life to the full. He formed an enduring friendship with John Herschel [the son of the leading scientist of England], who had entered St. John's College in 1809, and relished the company of wide circle of friends. He played chess, took part in all-night sixpenny whist sessions, and bunked lectures and chapel to sailing on the river with his chums."

Before commenting on this excerpt, turn to the second.

> ". . . The heroes of the age laid much of the foundation for modern scientific and industrial life—Michael Faraday, Charles Wheatstone, Humphrey Davy, John Dalton, Isambard Kingdom Brunel, Joseph Whitworth and Charles Darwin. It was also an age of quantification in which science and engineering set about reducing the world to number. With the rise of science and the burgeoning Industrial Revolution, the need for accurate and convenient numerical calculations mushroomed."

All but the concluding sentence of that latter excerpt, is pretty much standard empiricist's mythological fustian, with no better than a few, almost accidental connections to the comparative developments in North American, Continental Europe, and England during the first quarter of the Nineteenth Century. The fact of the matter is, that, during that period, but for the work of John's father, William Herschel, the state of science and technology in England and its universities, represented a stagnant backwater in the development of science and technology.

Indeed, that was the point which William's son, John Herschel, Babbage, and their friends made, in translating a modern French calculus text into English, in their efforts to introduce competence into the moribund mathematics training in England at that time. Moreover, within the ebullient wit of their student-years publication, "D-ism and Dot-age," they presented shocking proof that this was the state of science and mathematics in England at that time.

Moreover, the historical significance of the work of Herschel, Babbage, et al., from the beginning of their collaboration in this matter, was that they succeeded in provoking relevant English reformers to bring about the revival of science and technological progress in England during the second quarter of that century. The establishment of the British Association for the Advancement of Science (BAAS), whose colonial branch became the American Association for the Advancement of Science (AAAS), was an outgrowth of the success of Herschel, Babbage, et al., to expose, and remedy somewhat the virtually bankrupt condition of English science during the period of, and immediately following the Napoleonic wars.

The relevant fact is, that from the accession to power in France, by the networks of Cardinal Mazarin and his protégé Jean-Baptiste Colbert, until the increasing decadence of France's Ecole Polytechnique under the Restoration monarchy, France was, beyond reasonable objections, the center of the progress of science and technology for the world as a whole. The work of Desargues, Fermat, Pascal, Huyghens, Leibniz, and the Swiss Jean Bernouilli, typified this Paris-centered network, which came, by the close of the Seventeenth Century, to be a world-wide leadership in science, centered around Leibniz's ***Acta Eruditorum.*** The role of England's Royal Society merely sat at the table of continental science in this respect.

Later, during the middle of the Eighteenth Century, all of the leading currents in European culture, including science, were embroiled in a virtual war, a contest between two opposing currents. On the one side, there was the Classical faction, gathered around such figures as the scientist Abraham Kästner at Göttingen University, Kästner's Gotthold Lessing, and Moses Mendelssohn. On the opposing side, was the anti-Classical, Romantic school, typified by the empiricists and the Cartesians, of the Eighteenth-Century British and French Enlightenment. The former, typified by Kästner, Lessing, and Mendelssohn, were openly avowed defenders of the legacy of Leibniz and J.S. Bach. Thus, until the emergence of the leading influence of Kästner's former student Gauss, with the success of Gauss's Ceres project, the center of development of physical science and mathematics, was in the Leibniz tradition of France's Gaspard Monge and his associates Lazare Carnot and A.M. Legendre, while leadership in Classical artistic culture was centered in the Germany of poets and thinkers, that of Kästner, Lessing, Mendelssohn, Haydn, Goethe, Mozart, Schiller, and Beethoven.

During the period from 1789 through 1827, history witnessed the transfer of leadership in science from the France of Monge, Legendre, and Lazare Carnot, into the Germany of Gauss and Alexander von Humboldt. Ecole Polytechnique member Alexander von Humboldt served as the key figure in moving scientific leadership from under the decadent influence of the Restoration monarchy and its Augustin Cauchy, into Germany. Gauss served, together with Ecole Polytechnique veteran Lejeune Dirichlet, as Humboldt's key figures in the emerging supremacy of German science. Charles Babbage, not accidentally, was a participant in the extended circles of Humboldt.

It was during the pre-Vienna Congress period, while the Napoleonic wars were still ongoing, that Gauss's work in astronomy electrified all Europe's scientific circles. Astronomer William Herschel, the father of astronomer John, was part of the circles of Gauss at that time.

Thus, the material from the three paragraphs quoted above, shows that Swade's studies had made him aware of the setting and significance of Herschel's and Babbage's attacks on the bankruptcy of English science at the time of Babbage's Cambridge years; it shows, that, for whatever reason, Swade elected to attempt to divert the reader's attention from such matters, by the relevant sort of what today's American vernacular terms euphemistically, "spin."

Otherwise, we should be pleased that Swade and his institution have done the sort of work which is described in the concluding section of that book. The account is useful as well as pleasant reading. However, if the economy of the United Kingdom is to be rescued from the disaster so aptly summarized in recent statements by Michael Heseltine and Anthony Wedgwood Benn, much thought and effort will be needed, to develop the young scientific and industrial cadres needed to effect a viable sort of modern reindustrialization of England's economy.

In that connection, two points which I have stressed here, ought to be leading concerns of those, of author Swade's generation, who are either coming into senior positions of responsibility at this time, or have already arrived there.

First, the aspect of the Babbage case which I have stressed here, should be studied in comparing the ruined situation of British science and technology, during the period of the Napoleonic wars and immediately following, to the ruinous situation to which Wedgwood Benn, Heseltine, and Ken Livingstone, among many others, have made reference recently.

Second, relevant parties in the U.K. must recognize, that the new leading issues of science and technology, under the emerging "post-information society" epoch now erupting, requires a ridding of science and economic policy of the curse of "ivory tower" mathematics. The frontiers of science and technology today, lie in the domain of the non-linear properly defined, in respect of living processes, microphysics generally, and elsewhere. To master those frontiers, requires both the scientific cadres and skilled industrial labor and farmers, qualified for that sort of job.