The Printed Papers of Charles Babbage

ALFRED W. VAN SINDEREN

This paper is intended to correct the list of printed papers of Charles Babbage (1791–1871) that Babbage printed in the back of his partial autobiography, **Passages from the Life of a Philosopher** *(London, 1864). That list has been reprinted in several modern publications, but no attempt has been made to make it accurate or complete until this article. In an effort to make the list more useful to the reader, notes follow many of the items to explain their significance in Babbage's life and work.*

No manuscript items are included; the paper deals only with Babbage's list of printed works, as they existed at the time of his death.

Keywords and phrases: Babbage, bibliography, publications, mathematics, Analytical Engine, Difference Engine

CR category: 1.2

Introduction

"I have frequently had applications to write my life, both from my countrymen and from foreigners," wrote Charles Babbage in *Passage from the Life of a Philosopher* (1864, p. vii); "to many of these I sent a list of my works, with the remark that they formed the best life of an author."

Indeed they do, in large measure, when accurately listed and their significance at least partially explained. Unfortunately, Babbage's lists were not accurate, nor were they supplemented with any explanation or description. This paper attempts to correct that situation and thereby assist the reader who wishes more fully to understand and appreciate this gifted and farsighted man. A few preliminary words are needed for the benefit of those who know little about Babbage, his life, and his work.

Charles Babbage, the Man

For the past 25 years or so, Charles Babbage has been known as a scientific pioneer whose work presaged the development of modern computer technology. Many words of praise were written about Babbage after his death in 1871, but modern evaluation of his work probably took hold in 1953 with the publication of B. V. Bowden's *Faster Than Thought.*[1] Calling Babbage "one of the most farsighted men of his generation," Bowden went so far as to say: "he understood clearly all the fundamental principles which are embodied in modern digital computers." Speaking of the Analytical Engine, which was Babbage's second major effort in calculating machines, Bowden described it as the "first universal digital computer, as the expression is understood today." Bowden did not attempt to prove a direct connection between the Analytical Engine and the computer technology of the 1950s, and that issue is still debated today.

Other writers have examined Babbage's machines in more detail. Philip Morrison and Emily Morrison (1961) drew heavily on Babbage's own descriptions of his work and on a book by the inventor's son, Henry P. Babbage, published in 1889. Perhaps the most thorough study of Babbage's engines is Bruce Collier's unpublished Ph.D. thesis (1971), "The Little Engines That Could've."

Characteristically, Babbage did not carry through to conclusion any of his efforts on calculating engines. He worked 10 years on his first Difference Engine, which was designed to calculate and produce mathematical tables. As discussed in Collier's dissertation, Babbage frequently enlarged his vision of what the machine could be made to do, which kept it in a constant state of redesign. There were mechanical problems stemming from the state of the art in making machinery at that time. He also encountered considerable difficulty with support from the British government because of misunderstandings that are too complex to recount here. These delays and problems allowed him time to think of a whole new concept (the Analytical Engine), and he pursued the design of this concept off and on for the rest of his life. During the late 1840s, he worked for a while on another machine he called Difference Engine No. 2. All of these efforts, including his relations with government, are discussed by the Morrisons and are summarized or glossed over lightly by several other authors.[2] Anyone interested in the whole story should con-

Author's address: 227 Church Street, New Haven, CT 06506.

© 1980 AFIPS 0164-1239/80/020169–185$01.00/0

[1] Bowden's first chapter, "A Brief History of Computation," includes a short life of Babbage (pp. 7–22).

[2] See, for example, Bernstein (1964), Rosenberg (1969), and Halacy (1970).

sult Charles R. Weld's *History of the Royal Society* (1848, Ch. 11) or Henry Babbage's book, previously mentioned.

Babbage was initially recognized as a mathematician; together with two or three of his friends, he reformed the teaching of mathematics in English universities. This story was told by W. W. Rouse Ball in 1889 and is also described in John M. Dubbey's 1978 book. Actually, Babbage dabbled in many branches of scientific work, including cryptology (Kahn, 1967). He conducted vigorous efforts to reform the scientific organizations of the period, especially the prestigious Royal Society (Babbage, 1830). This part of his life, including his special friendship with Lady Lovelace (the only daughter of Lord Byron), is recounted by Maboth Moseley (1964) and Doris Langley Moore (1977). A detailed account of Babbage's reform efforts and of his many contributions to science is found in Walter L. Bell's unpublished dissertation (1975), "Charles Babbage, Philosopher, Reformer, Inventor."

Alfred W. Van Sinderen has worked for the Southern New England Telephone Company in New Haven since 1947 and has been its president since 1967. A book collector most of his life, he began his Babbage collection in 1964 after attending the Bell System Data School in Cooperstown, NY. This collection has been Van Sinderen's principal avocation ever since and now numbers about 85 printed items and 115 letters or manuscript items.

Babbage's support of the general progress of science in Great Britain may well be his most significant contribution. It was more thoroughly recognized during his own lifetime than were his efforts to design and construct a calculating engine. A letter dated June 1, 1836, from Sir Charles Lyell, president of the Geological Society, to Sir John F. W. Herschel, former president of the Royal Astronomical Society, is a case in point (Lyell, 1881):

> Babbage gave one of his evening meetings, which are very brilliantly attended by fashionable ladies as well as literary and scientific gentlemen, where one meets with persons high in all professions.
>
> Babbage must be admitted to have really succeeded in commanding the respect and admiration of persons of the first talent but also of wisdom and beauty. I think he has done good and acquired influence for science by his parties and the manner in which he has firmly and successfu asserted the rank in society properly due to science.

Babbage's "Printed Papers"

Although many people, including those alread mentioned, have written about Charles Babbag or some phase of his life, none seems to hav applied to that life the measurement Babbag would have used himself. In letter after letter i the extensive collection at the British Library, h cites "a list of his writings" as the best autobio raphy a person can write. Babbage's obituar notice in the *Times* (October 23, 1871) containe the following: "He would uniformly express a opinion that the only biography of living persor ages was to be found ... in the list of thei published works." One would think, therefor that Charles Babbage would have taken grea care to see that his published works were accu rately listed. He published such lists on severa occasions during his life, usually as appendixes t other volumes. The final list appeared in 186 on pages 493–496 of the partial autobiography quoted at the beginning of this article.

It was something of a surprise to discover tha this list of 80 "printed papers" (which included some books as well as monographs and period ical papers) contains 47 errors. Actually, 8 items are listed; number 52 is repeated as two separate items, and number 35 includes two items without separate numbers. Eleven of the items do not belong in the list: three were not written by Babbage, as he himself pointed out; two were never published; two were not even printed; and four were listed more than once. Eight items are not included in the list, although two of these were published after 1864. Thus, the accurate count should be 79.

In addition, there are mistakes in the titles of printed works; several incorrect dates of publication, including one that is off by ten years; three incorrect page numbers in scientific periodicals; two cases in which the place of publication is in error; and two in which the name of the periodical itself is wrong (these two were the most difficult to find).

It is likely that people will continue to write about Charles Babbage and that someone will one day produce a full and accurate biography. Therefore, it seems fitting to correct the "List of Mr. Babbage's Printed Papers" and to add some notes about the significance of the various writings so as to fulfill Babbage's original intent.

The following list was compiled by examining the printed works of Charles Babbage as they are found at the British Library; at the university libraries of Cambridge and Oxford; in a special collection of Babbage materials at the Old Ashmolean Building at Oxford; at the Crawford Library of the Royal Observatory in Edinburgh; at the Library of Congress, Washington, DC; at the Boston and New York public libraries; at the Computer Center Library at Harvard; and at the Sterling and Beinecke libraries at Yale. The National Union Catalogue at the Library of Congress was especially helpful in locating items that are in only one or two places.

Acknowledgments

Untold numbers of faithful librarians assisted me in this effort and I cannot thank them all. Certain people were of special help, and they should be recognized.

Miss Margaret Eschler, currently of Bern, Switzerland, but at one time a member of the staff of the Beinecke Library at Yale, investigated an enormous number of questions for me both in the bowels of the vast Yale Library system and in considerable correspondence with other libraries. Without her help, this paper would not exist.

Mr. Colin Clair of London, who holds the oldest outstanding reader's card in the British Library, assisted me mightily in uncovering some of the items I simply couldn't find or understand and also obtained access for me to the Babbage letters in the British Library. I shall never forget his kindness and consideration.

Mr. Robert E. Balay, head reference librarian at the Sterling Memorial Library at Yale, helped me correct the bibliographic listings of the various items and also found several errors in my work. Because of his expert advice, I have much greater confidence in the accuracy of this article.

Finally, I am indebted to Professor Brian Randell of the University of Newcastle and two referees who assisted him in an editorial review of this paper. Most of their suggestions have been adopted and the work has been improved thereby.

REFERENCES

Atherton, William H. (ed.). 1899. *How to Invent Machinery* by the late Charles Babbage, edited and supplemented by William H. Atherton. Manchester: Vulcan.

Babbage, Charles. 1830. *Reflections on the Decline of Science in England*. London: B. Fellowes.

Babbage, Charles. 1864. *Passages from the Life of a Philosopher*. London: Longman, Green, Longman, Roberts & Green.

Babbage, Henry P. 1889. *Babbage's Calculating Engines*. London: E. & F. N. Spon.

Ball, Walter William Rouse. 1889. *A History of the Study of Mathematics at Cambridge*. Cambridge: University Press.

Bell, Walter Lyle. 1975. "Charles Babbage, Philosopher, Reformer, Inventor: A History of his Contributions to Science." Ph.D. dissertation. Corvallis: Oregon State University.

Bernstein, Jeremy. 1964. *The Analytical Engine*. New York: Random House, pp. 30–46.

Bowden, Bertram Vivien (ed.). 1953. *Faster Than Thought; A Symposium on Digital Computing Machines*. London: Sir Isaac Pitman & Sons, pp. 7–22.

British Association for the Advancement of Science. 1834. *Report of the Third Meeting of the British Association for the Advancement of Science; Held at Cambridge in 1833*, 3. London: John Murray.

Collier, Bruce. 1971. "The Little Engines That Could've: The Calculating Machines of Charles Babbage." Ph.D. dissertation. Cambridge, MA: Harvard University.

Dubbey, John Michael. 1978. *The Mathematical Work of Charles Babbage*. Cambridge: Cambridge University Press.

Halacy, Dan. 1970. *Charles Babbage, Father of the Computer*. New York: Crowell-Collier.

Kahn, David. 1967. *The Code Breakers*. New York: Macmillan, pp. 204–207, 240, 765–776.

"The Late Mr. Charles Babbage, F.R.S." [Obituary notice]. 25 October 1871. *Times* (London), p. 12.

Lyell, Sir Charles. 1881. *Life, Letters and Journals of Sir Charles Lyell, Bart.*, ed. by his sister-in-law, Mrs. [Katherine Murray Horner] Lyell. London: J. Murray, pp. 164–167.

Moore, Doris Langley. 1977. *Ada, Countess of Lovelace*. New York: Harper and Row.

Morrison, Philip, and Emily Morrison (eds.). 1961. *Charles Babbage and His Calculating Engines*. New York: Dover.

Moseley, Maboth. 1964. *Irascible Genius*. London: Hutchinson & Co.

Rosenberg, Jerry. 1969. *The Computer Prophets*. London: Macmillan, pp. 52–85.

Taylor, Richard (ed.). 1843. *Scientific Memoirs*. London: Richard and John E. Taylor, Vol. 3, pp. 667–731.

Weld, Charles R. 1848. *A History of the Royal Society*. London: J. W. Parker.

Format of List

The items (from *Passages from the Life of a Philosopher* and other sources) are arranged in date order to the best of my ability, following Babbage's system, but there are a few instances in which lack of evidence makes it difficult to be precise about the exact date of publication. In these cases, the facts known are recounted and some reasonable conclusion drawn. Following each number in the list is a notation such as "CB 15," which means that this item was listed 15th on Babbage's list of 80, or "NL in CB," which means not in Babbage's list. Items in Babbage's list that should not be included are numbered in parentheses—such as (CB 35).

Abbreviations

Edin. Journ. Sci.
The Edinburgh Journal of Science

Edin. Phil. Journ.
Edinburgh Philosophical Journal

Journal of Science
Journal of Science and the Arts (also known as the *Royal Institution Journal*)

Journ. Soc. Arts
The Journal of the Society of Arts

Journ. Stat. Soc.
Journal of the Statistical Society of London

Mem. Astron. Soc.
Memoirs of the Astronomical Society of London (later *Royal Astronomical Society*)

Phil. Mag.
Philosophical Magazine

Phil. Trans.
Philosophical Transactions of the Royal Society of London

Proc. Geol. Soc.
Proceedings of the Geological Society of London

Quart. Journ. Geol. Soc.
The Quarterly Journal of the Geological Society of London

Trans. Camb. Phil. Soc.
Transactions of the Cambridge Philosophical Society

Trans. Royal Soc. Edin.
Transactions of the Royal Society of Edinburgh

BABBAGE'S PRINTED PAPERS

		Date	*Title*	*Periodical or Publisher*
1	CB 1	1813	"Preface"	*Memoirs of the Analytical Society*, Cambridge (1813), i–xxii
2	CB 2	1813	"On Continued Products"	*Memoirs of the Analytical Society*, Cambridge (1813), 1–31
			The authors of the above two items were not stated in the *Memoirs*, the only volume published by this undergraduate society. Item 1 was jointly written with J. F. W. Herschel and item 2 by Babbage alone. Babbage consistently attributed these articles to himself and Herschel; other members of the society, such as George Peacock, Edward Ryan, and Frederick Maule, confirmed it; see Ball (1889, pp. 120–128) for further information on the Analytical Society; also, Dubbey (1978, Ch. 3).	
3	CB 3	1815	"An Essay Towards the Calculus of Functions"	*Phil. Trans. 105* (1815), 389–423
			Communicated by W. H. Wollaston, Secretary of the Royal Society. Read June 15, 1815.	
4	CB 4	1816	"An Essay Towards the Calculus of Functions, Part II"	*Phil. Trans. 106* (1816), 179–256
			Communicated by W. H. Wollaston, Secretary of the Royal Society. Read March 14, 1816.	
			In the above two articles, plus items 7 and 8 listed below, Babbage actually invented a new calculus, although he did not perfect it. Babbage had received a B.A. from Cambridge in 1814 and was working toward his M.A. (received in 1817). For full information on this effort, consult Dubbey (1978, Ch. 4).	
5	CB 5	1816	"Demonstrations of Some of Dr. Matthew Stewart's General Theorems; To Which Is Added, An Account of Some New Properties of the Circle"	*Journal of Science 1* (1816), 6–24
			Babbage wrote only three papers on geometry; the other two were items 21 and 38 below. Matthew Stewart, a Scottish mathematician, published his theorems in 1746 (Dubbey, 1978, pp. 143–152).	

173

6 CB 15 1816 [Translator] LaCroix, S[ilvestre] F[rançois] *An Elementary Treatise on the Differential and Integral Calculus* Cambridge: J. Deighton & Sons, 1816

A joint effort with John F. W. Herschel and George Peacock. Publication of this translation permanently altered the teaching of mathematics in England; differential and integral calculus soon replaced Newton's "Calculus of Fluxions." Babbage translated Part I, "Differential Calculus"; Herschel and Peacock jointly translated Part II, "Integral Calculus"; Herschel wrote the "Appendix," which was an addition, not a translation, and he and Peacock collaborated on the notes.

7 CB 6 1817 "Observations on the Analogy Which Subsists Between the Calculus of Functions and the Other Branches of Analysis" *Phil. Trans. 107* (1817), 197–216

Babbage incorrectly listed the page number of this item, the first paper he communicated as a Fellow of the Royal Society. Read April 17, 1817.

8 CB 7 1817 "Solutions of Some Problems by Means of the Calculus of Functions" *Journal of Science 2* (1817), 371–379

See note after item 4 above.

9 CB 9 1817 "An Account of Euler's Method of Solving a Problem, Relative to the Move of the Knight at the Game of Chess" "From a Correspondent" *Journal of Science 3* (1817), 72–77

No author was listed for this work in the *Journal of Science*. It is frequently attributed to Babbage by himself or others; listed by Babbage in all lists of his works.

10 CB 8 1817 "Note Respecting Elimination" *Journal of Science 3* (1817), 355–357

A short algebraic paper.

11 CB 10 1819 "On Some New Methods of Investigating the Sums of Several Classes of Infinite Series" *Phil. Trans. 109* (1819), 249–282

See Dubbey (1978, pp. 136–143) for discussion of this and items 12 and 14 below. Read April 1, 1819.

12 CB 11 1819 "Demonstration of a Theorem Relating to Prime Numbers" *Edin. Phil. Journ. 1* (1819), 46–49

13 CB 17 (CB 16) 1820 *Examples of the Solutions of Functional Equations* Cambridge: J. Deighton & Sons, 1820

This paper is part of a two-volume work entitled *Examples to the Differential and Integral Calculus* jointly written in 1820 by George Peacock, John F. W. Herschel, and Charles Babbage. The larger work is found in various forms: sometimes as one volume bound together, often as two volumes, and occasionally as three. Part I was written by Peacock; Parts II and III were written by Herschel and Babbage, respectively, and made up the second volume. The entire work was intended to accompany the translation of LaCroix's work listed as item 6. In Babbage's earliest list of printed papers (1834), he does not show this as two separate items. By 1851, and thereafter, he did use the title of the larger work as one item, CB 16, and the title of his own contribution to it as the second item, CB 17.

14 CB 12 1821 "An Examination of Some Questions Connected with Games of Chance" *Trans. Royal Soc. Edin. 9* (1821), 153–177

Described in the *Edin. Phil. Journ. 4* (1821), 417–423. Babbage's only paper on probability. Read March 21, 1820.

15 CB 13 1822 "Observations on the Notation Employed in the Calculus of Functions" *Trans. Comb. Phil. Soc. 1* (1822), 63–76

Read February 26, 1820, this was the first of a series of three long papers on mathematical notation. The other two are items 30 and 37 below. From this early interest in a neglected section of mathematical study (Dubbey, 1978, p. 154) arose Babbage's system of Mechanical Notation (see items 27 and 60, and Henry Babbage's paper listed as CB 73). Mechanical Notation was fundamental to all the design work Babbage did on the Difference Engine and the Analytical Engine.

		Date	Title	Periodical or Publisher
16	CB 46	1822	"Barometrical Observations Made at the Fall of the Staubbach" by J. F. W. Herschel and Charles Babbage	*Edin. Phil. Journ. 6* (1822), 224–227

Transmitted in a letter from Babbage to David Brewster, editor of the *Edin. Phil. Journ.*, dated December 7, 1821, this article was listed by Babbage as having been published in 1832. This error occurred in the first list published and was never corrected. Babbage listed the paper as being published in Brewster's *Edin. Journ. Sci.*, which was the name taken by the *Edin. Phil. Journ.* in 1824.

17	CB 18	1822	"A Note Respecting the Application of Machinery to the Calculation of Astronomical Tables"	*Mem. Astron. Soc. 1* (1822), 309

Read June 14, 1822, this short paper introduces the idea of the Difference Engine that is then developed fully in items 18, 20, and 19 (actually written in that order). As a result of this work, Babbage was presented with the Gold Medal of the Astronomical Society on July 13, 1823.

18	CB 19	1822	*A Letter to Sir Humphry Davy, Bart, President of the Royal Society, on the Application of Machinery to the Purpose of Calculating and Printing Mathematical Tables*	London: J. Booth; Baldwin, Cradock & Joy, 1822

This item was reprinted in *Great Britain, Parliament, House of Commons, Sessional Papers* (1823), Vol. 15, 9–16.

In 1822, a paper was published in the *Edin. Phil. Journ. 7* (1822), 274–281, entitled "On Machinery for Calculating and Printing Mathematical Tables." This paper was attributed by the editor to Babbage and was so printed in the Table of Contents. Actually, it was an abstract of the above letter to Sir Humphry Davy, and evidence suggests that it was written by Brewster, editor of the *Edin. Phil. Journ.* Babbage included this item in one of his lists (1847) but omitted it thereafter.

19	CB 21	1822	"Observations on the Application of Machinery to the Computation of Mathematical Tables"	*Mem. Astron. Soc. 1* (1822), 311–314

Babbage listed the date of publication as 1824. Read December 13, 1822.

20	CB 20	1823	"On the Theoretical Principles of the Machinery for Calculating Tables"	*Edin. Phil. Journ. 8* (1823), 122–128

In a letter from Babbage to Brewster dated November 6, 1822.

21	CB 14	1823	"On the Application of Analysis to the Discovery of Local Theorems and Porisms"	*Trans. Royal Soc. Edin.* 9 (1823), 337–352

See item 5 above. Read May 1, 1820.

22	NL in CB	1823	[Joint editor with Francis Maseres] *Scriptores Optici; or, A Collection of Tracts Relating to Optics*	London: Baldwin, Cradock & Joy, 1823

This is a collection of eight works on optics started by Baron Maseres and finished at his request by Babbage (who also wrote a three-page "Preface" dated June 22, 1822). Francis Maseres (1731–1824), a professor of mathematics at Cambridge, published extensively on trigonometry, algebra, and the theory of equations. In 1807, he published a six-volume work *Scriptores Logarithmici;* the above volume, which was begun in 1810, was intended as a sequel to that work (Ball, 1889, p. 108). The various tracts were written by noted scientists such as James Gregory and Descartes. By the time they were received for editing and publication, Maseres was 90 years old and in poor health. He died the year after the book was published.

23	CB 23	1824	"Observations on the Measurement of Heights by the Barometer"	*Edin. Journ. Sci. 1* (1824), 85–87

In a letter to Brewster dated May 5, 1822, Babbage described the difficulties in measuring heights with a barometer unless a thermometer is also used to check air temperature.

175

24 CB 25 1825 "Account of the Repetition of Mr. Arago's Experiments on the Magnetism Manifested by Various Substances During the Act of Rotation" *Phil. Trans.* 115 (1825), 467–496

Jointly written by Babbage and Herschel. Other English mathematicians, such as Barlow and Christie, also performed experiments in magnetism during this period, stimulated by the work of Arago on the Continent. The whole subject was summarized in the *Edin. Journ. Sci. 4* (1826), 13–19.

25 CB 24 1826 "On a New Zenith Micrometer" *Mem. Astron. Soc. 2* (1826), 101–103

Read March 11, 1825. Illustrates Babbage's lifelong interest in tools.

26 CB 30 1826 *A Comparative View of the Various Institutions for the Assurance of Lives* London: J. Mawman, 1826

In 1824, Babbage was offered a position as manager of a new life assurance association, and consequently carried out considerable research on actuarial tables of life expectancy. This research formed the basis for this volume, but Babbage did not take the job. A German translation of this book was published at Weimar in 1827. Babbage did not discover this until he visited Germany that year. Advisors to the King of Bavaria discussed the German version with Babbage. The Gotha Life Assurance Company was established soon after in that part of Germany.

27 CB 28 1826 "On a Method of Expressing by Signs the Action of Machinery" *Phil. Trans. 116*, Pt. 3 (1826), 250–265 (with Plates VII-X)

This was the first effort to explore Mechanical Notation, a basic idea underlying all of Babbage's work on Calculating Engines. See note under item 15.

28 CB 27 1826 "On Electrical and Magnetic Rotations" *Phil. Trans. 116*, Pt. 3 (1826), 494–528 (with Plate XIX)

This was a further effort by Babbage to pursue the work undertaken in item 24. A German translation of this paper appeared in *Journal Für Chemie und Physik 49* (1827), 412–452, but was never taken note of by Babbage, who complained that it received "little acceptance" (Morrison and Morrison, 1961, p. 143).

29 CB 22 1826 "On the Determination of the General Term of a New Class of Infinite Series" *Trans. Camb. Phil. Soc. 2*, Pt. 1 (1827), 217–225

There is some question as to the exact publication date of this item. Babbage lists it as 1824, which is when the paper was read. The Cambridge Philosophical Society was a fairly new organization and did not publish its transactions every year (see item 15). Vol. 2 carries a publication date of 1827, but it is divided into two parts and indications are that Part 1 was published in 1826 and later combined with Part 2. In the *Phil. Mag. 67* (1826), 259–265, the above paper is described and a notation is made that the paper is "just published." This is the best evidence for fixing publication date in 1826.

30 CB 29 1827 "On the Influence of Signs in Mathematical Reasoning" *Trans. Camb. Phil. Soc. 2*, Pt. 2 (1827), 325–377

This paper appears in the same volume as item 29 but is contained in Part 2 published in 1827 even though the paper was read December 16, 1821. Offprints of the paper carry the publication date as 1826, which is the way Babbage lists it. Such offprints, however, were usually furnished to authors in advance of official publication for distribution to their friends. Babbage incorrectly lists this article as appearing on p. 218. See note under item 15.

31 CB 26 1826 "Diving Bell" *Encyclopaedia Metropolitana 18* (1845), 157–167

Here, again, it is difficult to assign a precise publication date. The *Encyclopaedia Metropolitana* was compiled over a 28-year period from 1817–1845 and volumes were issued as finished. These early volumes are virtually impossible to find, but the whole work was first published in 1845. Babbage's article appears in Vol. 18, but that was not the eighteenth book produced. The volume is one of those entitled "Miscellaneous." The content of the *Diving Bell* article itself contains reference to experiments at Plymouth in 1825 and 1826. In *Passages* (1864, p. 494), Babbage claims 1826 was the publication date, accepted here for lack of better evidence.

		Date	Title	Periodical or Publisher
32	CB 35	1827	"Notice Respecting Some Errors Common to Many Tables of Logarithms"	*Mem. Astron. Soc. 3* (1827), 65–67

See note following item 33 below.

(CB 35)

Following the above item in Babbage's list, but without a separate enumeration, is this entry: "Evidence on Savings Banks, before a Committee of the House of Commons, 1827." This item is not found in earlier lists from 1834–1851. It should not have been included at all because it was not "written" by Babbage and was never printed.

In the *Reports from the Committees of the House of Commons*, Vol. III, 1826–1827 (only copy in manuscript form is in the British Museum; now in the process of being microfilmed), is the following item (p. 869, #558): "Minutes of Evidence before Select Committee on laws respecting Friendly Societies, 1827." There follows a description in the handwriting of the committee clerk of joint evidence given by Benjamin Gompertz and Charles Babbage as to annuities and death benefits. Babbage testified as an expert on mathematical tables.

An Act of Parliament, dated June 21, 1827, directs that "Friendly Societies may subscribe part of their funds into the funds of any institution which shall take the benefit of this Act with respect to the establishment of annuities." Evidently, "friendly societies" were equivalent to savings banks and Babbage's testimony was useful in this particular instance. Interesting, but not a "printed paper."

33	CB 33 (CB 34)	1827	*Table of Logarithms of the Natural Numbers from 1 to 108,000*	London: J. Mawman, 1827

Incorrectly listed by Babbage as 1826, this "Book of Tables" had many editions, foreign translations, and reprintings. It was a major effort to print in stereotype—for protection against errors—a really accurate set of logarithmic tables. Babbage checked his work against Callet, Hutton, Vega, Briggs, Gardiner, and Taylor, all of whom had published logarithmic tables of various sizes between 1633 and 1804. As a result of this, only nine errors were found in the first edition. These were printed as a list of errata following the 12-page preface in a different printing of the first edition published by B. Fellowes in 1829. A second edition in 1831 incorporated these corrections and slightly changed the introduction.

A third edition (listed by Babbage as CB 34) was published by Charles Knight printed on green paper for the Hungarian Academy of Sciences. The introduction of this edition was translated into Hungarian and separately into German by Charles Nagy, who wrote a preface of his own for each of these foreign editions. A variation of these translations has Nagy's preface in Hungarian and a German translation of Babbage's preface and introduction. All of these foreign editions were printed in London by W. Clowes rather than at Pesth and Vienna as indicated by Babbage. A fourth impression, which is identical to the third edition, was printed in English in 1841 by W. Clowes; a fifth impression was printed by J. Murray in 1844. E. & F. N. Spon published another impression in both London and New York in 1872 after Babbage's death, and further printings were published in 1889, 1912, and 1915. In all that time (1831–1915), no one was able to discover any errors in the tables.

34	CB 38	1829	"Account of the Great Congress of Philosophers at Berlin on the 18th September 1828" "Communicated by a correspondent"	*Edin. Journ. Sci. 10* (1829), 225–234

Although no author of this article was listed at the time of publication, Babbage and many others, including Brewster, attributed the account to him. The item was not listed in any of Babbage's lists until the last one (1864), although it was reprinted by him in *Decline of Science* (item 39), pp. 213–223.

35	CB 37	1829	"A Letter to the Right Hon. T. P. Courteney, on the Proportionate Number of Births of the Two Sexes Under Different Circumstances"	*Edin. Journ. Sci. NS 1* (1829), 85–104

This item is frequently found separately bound (sometimes in hard cover) and with a

177

title page. It was also translated into French by M. Villermé and published in the *Annales D'Hygiene Publique 8* (1832), 445–453.

Babbage's interest in statistics led to the formation in 1833 of a Statistical Section of the British Association for the Advancement of Science (BAAS) (1834); Babbage was the first chairman. This development and the founding in 1834 of the Statistical Society of London are described in the "Address of Dr. Farr, President of the Statistical Society," in the *Journ. Stat. Soc. 34* (1871), pp. 411–413. Babbage was an active member of the Statistical Society for 37 years. See items 41, 44, 64, 72, and 74 for other papers on statistics.

36 CB 36 1829 "On the General Principles Which Regulate the Application of Machinery to Manufactures and the Mechanical Arts" *Encyclopaedia Metropolitana 8* (1845), 1–84

As noted under item 31, this encyclopedia was issued in separate volumes over the period 1817–1845. Although this was part of Vol. 8 in the final enumeration, it appears to have been originally published later than Vol. 18 in which item 31 appeared. A reprint of this article with the same title was published in *The Encyclopaedia of Arts, Manufactures and Machinery*, edited by Peter Barlow, and published in 1851. In that volume, Barlow says the paper was first printed in 1829, which is the date Babbage himself uses in his list. It should be noted that this work was preliminary to Babbage's *Economy of Machinery and Manufactures*, which was published in 1832 (see item 45 below).

37 CB 31 1829–1830 "Notation" *The Edinburgh Encyclopaedia 15* (1830), 394–399

On mathematical notation, not Mechanical Notation. See note under item 38 below.

38 CB 32 1830 "Porisms" *The Edinburgh Encyclopaedia 17* (1830), 106–114 (includes Plate 467)

The Edinburgh Encyclopaedia was edited by David Brewster and contained 18 volumes, the first issued in 1808 and the last in 1830. Most of the volumes were published near the end of that time, however, because Brewster was constantly changing the articles to include new discoveries in science. Babbage places no date on the publication of these two articles but by implication suggests they were published in 1827 because of the order of listing. They may well have been written in that year, but Brewster's discussion of his work in the introduction of 1830 suggests that all of the volumes after 12 were published in 1829 or 1830.

39 CB 40 1830 *Reflections on the Decline of Science in England* London: B. Fellowes, 1830

Usually found in the octavo size in which it has 228 pages, this book was also published in quarto size with only 120 pages. The dedication is to an anonymous person—in fact, Lord Ashley, Earl of Shaftesbury. The publication of this book marked the beginning of public conflict between Babbage and the Royal Society—a conflict that had been simmering for some years. This book was an attack on the ruling clique of the Royal Society and contained a "plan for sweeping reforms to the Society" (Morrison and Morrison, 1961, p. xxx). Despite the controversy aroused by this book, it did focus attention on the condition of scientific societies in England. The formation of the British Association for the Advancement of Science in 1831 by Sir David Brewster, Sir John Robison, and the Rev. William Vernon Harcourt was a direct result (Moseley, 1964, p. 128).

40 CB 41 1830 *Sketch of the Philosophical Characters of Dr. Wollaston and Sir Humphry Davy* London: B. Fellowes, 1830

Although referred to as an extract from item 39, this must be considered a separate work. It is based on the Conclusion of item 39, but the wording is rearranged and some added. There was a regular title page, as shown above. Although rare in the United States, the pamphlet was widely circulated in England and is found in some libraries that do not contain the book from which it was extracted.

41 CB 42 1831 "Sur l'emploi plus ou moins fréquent des mêmes lettres dans les différentes langues" *Correspondance mathématique et physique 7* (1831), 135–137

This was a letter from Babbage to L. A. J. Quetelet, editor of the *Correspondance*, who translated the letter into French and published it as noted. In his list, Babbage uses an English title *On the Proportion of Letters Occurring in Various Languages*, lists the volume number and page number incorrectly, and gives no date of publication. It was never published in England.

		Date	Title	Periodical or Publisher
42	CB 43	1831	*Specimen of Logarithmic Tables* (21 vols.)	London: B. Fellowes, 1831

This extraordinary work was described in detail in Brewster's *Edin. Journ. Sci. NS 6* (1832), 144–150. The only copy ever made, or in existence, is found in the Crawford Library of the Royal Observatory in Edinburgh. The object of the work was to ascertain by experiment the tints of paper and colors of ink least fatiguing to the eye. One hundred fifty-one different tints of paper were chosen (Brewster's article quotes Babbage as stating "140," but 151 is correct). The same two pages from the second edition of item 33 were printed on them in the following colors of ink: light blue, dark blue, light green, dark green, olive, yellow, light red, dark red, purple, and black. The pages reproduced were those containing logarithms of the whole numbers beginning with 99,700. There were two volumes apiece for each color ink and the pages were numbered throughout these first 20 volumes so that similar papers could be compared with different inks. Generally speaking, the sets of two volumes were identical, but accidents in printing occasionally caused one or more pages to be omitted. In the 21st volume, Babbage used metallic inks, including gold, silver, and copper on vellum and various selections from the colored papers.

Babbage's discussion of this experiment in the preface (reprinted in each volume) raised the following points: (1) whether white paper is as good as lightly tinted papers; (2) whether black ink is preferable to all others; (3) whether strong or weak light makes a difference as to the ink used; (4) whether daylight or artificial light makes a difference as to the paper used; (5) whether peculiarities in the vision of individuals, or the general state of their health, make a difference; (6) whether some colors of ink and paper are most agreeable to the majority.

Brewster made several conclusions in the article mentioned above. Black ink on white paper offers the greatest contrast and is therefore best, but black ink on lightly tinted paper is best in strong light (i.e., sunlight). Dark colored papers are always more fatiguing, but, if used, should have matched or blended color inks for best results. Best colors for those with poor vision vary widely with the individual. While white paper is always preferable, the best colored paper is bluish green of a modest hue. Brewster says the experiment was done for use on the output of Babbage's Calculating Engines.

43	NL. in CB	1831	*Table of Logarithms of the Natural Numbers from 1–108,000 on Different Coloured Papers*	London: B. Fellowes, 1831

This was another experiment utilizing different colored papers, but only black ink. Again, only one copy was made; it is also found in the Crawford Library. It may not have been printed until 1832 because it was not mentioned in Brewster's analysis of item 42. There are 28 volumes (Babbage said there were 35), each a complete copy of the second edition of Babbage's *Tables* (item 33). Either four volumes or three were used for most of the colors, with the early pages of each set being of a very dark shade and each two pages being successively lighter until the final pages were almost white. The first four volumes were on pink paper, the next four on green, then three on blue, four on salmon, three on brown, three on purple, and four on yellow (total 25). One volume each was then added with all pages of identical color printed on fawn, yellow, and white paper, making a grand total of 28 volumes. Babbage made a minor note of these volumes under item 42 but did not number or describe them.

44	CB 45 (CB 39)	1832	"On the Advantage of a Collection of Numbers, to be Entitled the Constants of Nature and of Art"	*Edin. Journ. Sci. NS 6* (1832), 334–340

The statistical concept expressed in this article appears in several forms, but was first published here. It illustrated certain constants of nature with respect to the Order of Mammalia. Another version, somewhat expanded and translated into French, appeared as "Sur Les Constantes De La Nature—Classe Des Mammiferes" (*Compte Rendu Des Travaux du Congrès Général De Statistique*, 1853, Bruxelles, pp. 222–230), and the most complete edition of the paper entitled "On Tables of the Constants of Nature and Art" is found in *The Annual Report of the Board of Regents of the Smithsonian Institution* for the year 1856, published in Washington, DC, 1857, pp. 289–302.

Babbage's inclusion of this item at various places in his list is confusing. He first lists it as being published in the *Edin. Journ. Sci. NS 1* (1829), 187, under the title "Note on the Description of Mammalia" (CB 39). That particular article is not a paper but a reference by the editor to the fact that Babbage had prepared a table describing the properties of mammalia.

A French translation of this notation appeared in the *Ferussac Bulletin 26* (1831), 296, as noted by Babbage, but this is not a paper either. Babbage said the paper was reprinted in the report of the third meeting of the British Association for the Advancement of Science held in Cambridge in 1833, but the only thing found there is a reference to the article in Brewster's *Edin. Journ. Sci.* Babbage did correctly list the French translation referred to above, but he makes no mention of the Smithsonian Institution publication, which is the most complete version of the paper.

45 CB 44 1832 *On the Economy of Machinery and Manufactures* London: C. Knight, 1832

This book was the most complete and professional job of writing Babbage ever did, as evidenced by the large number of editions, reprints, and foreign translations that were produced and the favorable reviews that accompanied its publication not only in England but in other countries as well.

It is generally regarded as a pioneer work on "operations research" (Morrison and Morrison, 1961, p. xxvi). Based on experience gained from visits to various forms of "manufactures" (factories), Babbage outlined many principles of modern technology, including regulation of power, control of raw materials, division of labor, time studies, the advantages of size in manufacturing, inventory control, and duration and replacement of machinery.

A second edition, which added three new chapters (see item 46), was published in 1832; a third edition in 1833 added extensively to six chapters, put the new chapters of the second edition in their proper sequence, and made other minor additions; a fourth edition, adding only an index, was published in 1835. A second printing of the fourth edition appeared in 1841 and another printing in 1846.

An American reprint of the first edition was published in Philadelphia in 1832; a German translation of the first edition was published in Berlin in 1833; a French translation by Edouard Biot of the third edition appeared in 1833, and the same was published again in Brussels in 1834. A partial translation of the third edition with some rearrangement by M. Isoard was published in Paris in 1834.

Italian translations of the third edition appeared in Florence in 1834 and in Turin in 1863 translated from Biot's French. A Spanish translation of the third edition was published in Madrid in 1835, and Swedish and Russian editions were published the same year. The final translation came out in 1880 after Babbage's death; it was by Charles Laboulaye, who followed the translation of Biot but altered it somewhat. An extract of the book (*How to Invent Machinery*, Manchester: Vulcan), with some additions by the editor, William H. Atherton, was published in 1899. The fourth edition was reprinted in New York by Augustus M. Kelley in 1963.

46 NL in CB 1833 *On Currency, on a New System of Manufacturing, and on the Effect of Machinery on Human Labour* London: C. Knight, 1833

This pamphlet consists of three chapters that first appeared in the second edition of item 45; the publication was intended for purchase by owners of the first edition of that book. The chapter on currency was called "Of Money, as a Medium of Exchange" and was more extensive than the version in the second edition. The three chapters, as found here, were used in the third edition but rearranged in sequence so as to follow the flow of the book better. The pamphlet sold widely and is found extensively in British libraries and museums. In the United States, the only copy is in the Baker Library at the Harvard Business School.

47 CB 75 1833 *A Word to the Wise* London: J. Murray, 1833

This pamphlet was originally published under the title shown above and was reprinted in 1856 with a subtitle "Observations on Peerage for Life." The 1856 printing was called a second edition but, with the exception of the subtitle, was precisely the same as the 1833 work. In his list of 80 printed papers, Babbage shows it as being printed in 1856.

		Date	Title	Periodical or Publisher
48	CB 47	1834	*Abstract of a Paper Entitled "Observations on the Temple of Serapis at Pozzuoli; with Remarks on Certain Causes which May Produce Geological Cycles of Great Extent"*	London: Richard Taylor, 1834

The circumstances surrounding the publication of the original paper from which this is drawn, the abstract itself, and its appearance in the proceedings of the Geological Society are somewhat complex. The original paper, *Observations on the Temple of Serapis,* was read at the Geological Society of London on March 12, 1834. In a later publication (see item 57), Babbage inserted the following comment:

> This paper, by the request of the author, was returned to him soon after it was read, and has been in his possession ever since. Other avocations obliged him to lay it aside, and he only recently returned it to the Council, ready for publication. An abstract both of the facts and of the theory, drawn up by the author, was however printed in the "Proc. of the Geol. Soc." for March 1834, Vol. II, p. 72.

Actually, what appeared in the *Proc. Geol. Soc.* was not an abstract at all but merely a reference to Babbage's paper; also, the publication date of Vol. 2 of the *Proceedings* was 1838, not 1834.

The paper referred to here *was* an abstract, together with certain conclusions of Babbage's that were originally attributed to William Henry Fitton (1780–1861), physician, geologist, and longtime friend of Babbage. Fitton was president of the Geological Society at this time. The item is thus a privately printed paper, frequently accompanied by Babbage's first list of his printed works containing 42 items. See item 57 for publication of the full paper.

49	Nl. in CB	1835	"Correspondance" (Une lettre à M. Quetelet de M. Ch. Babbage relativement à la machine à calculer)	Académie royale des sciences, des lettres et des beaux-arts de Bruxelles, *Bulletins 2* (1835), 123–126

Title page reads: *Bulletins de l'Académie royale des sciences et belles-lettres de Bruxelles.* In this letter, Babbage outlines for the first time the design of the Analytical Engine and the things that make it different from the Difference Engine.

> I am myself astonished at the power I have been enabled to give to this machine; a year ago I should not have believed this result possible. This machine is intended to contain a hundred variables ... each of these numbers may consist of twenty-five figures; ... and [will perform] any given function which can be formed by addition, subtraction, multiplication, division, extraction of roots, or elevation to powers [the English translation is taken from Taylor's *Scientific Memoirs,* 1843, Vol. 3, pp. 667–668].

The letter also describes how the machine can substitute its calculation for one of the variables and then proceed to make other calculations. This is the first time a calculating engine was envisioned that would take action according to its own prior results—a fundamental concept of modern computer design.

Thus, this letter is one of the most significant communications in the history of early computer development, yet Babbage never included it in any list of his printed works. It is conceivable, although improbable, that he did not know Quetelet had published the letter at the time; but he must have known it later, for it is mentioned, as shown in item 55, in Taylor's *Scientific Memoirs* (1843).

50	CB 50	1835	"Letter From Mr A. Sharp to Mr J. Crosthwait, Hoxton, Feb. 2, 1721, Decyphered by C. Babbage, Esq. From the Original Letter in Shorthand," in Francis Baily, *An Account of the Rev.d John Flamsteed, the First Astronomer-Royal,* p. 348	London: Printed by Order of the Lords Commissioners of the Admiralty, 1835

This items contains a description of the deciphering on pp. 390–391. Baily had requested Babbage to help him unravel this letter to clear up a historical point (Kahn, 1967, p. 205).

181 51 CB 51 1837 *The Ninth Bridgewater Treatise: A Fragment* London: John Murray, 1837

Under the terms of his will, the Earl of Bridgewater had provided a bequest calling for the publication of eight treatises that would give evidence in favor of natural religion. Babbage decided to add a ninth at his own expense because of the prejudice that he felt was implied in the first volume of the series: that the pursuit of science and of mathematics, in particular, was unfavorable to religion (Morrison and Morrison, 1961, p. xxiii). Babbage concluded that "the Creator's works were proof of the existence of a Supreme Being and the greatest of these efforts was the creation of man" (Rosenberg, 1969, pp. 72–73). He also found opportunities to refer to his work on Calculating Engines and included a short appendix describing his efforts in that regard.

A second edition, revised with the help of Dr. Fitton (see item 48), was published in 1838. In the back of this edition was reprinted the list of printed papers sometimes found with item 48. A first American edition, based on the second London edition, was published in Philadelphia in 1841.

52 CB 52 1838 "On Impressions in Sandstone Resembling Those of Horses' Hoofs" *Proc. Geol. Soc.* 2 (1838), 439

Babbage's listing of the title of this item was incomplete.

(CB 52*) "A Short Account of a Method by Which Engraving on Wood May be Rendered More Useful for the Illustration and Description of Machinery" British Association for the Advancement of Science, *Report of the Eighth Meeting* 7 (1839), 154

Babbage listed the above as a separate item, making it the second entry with the number 52. Realizing this, he identified it as 52*. The item should not have been listed at all. The author presented a paper on the above subject to the BAAS at its meeting in Newcastle in August 1838, but the only thing printed was reference to the fact that the presentation was made. The paper itself was never reproduced.

53 CB 53 1839 *Letter from Mr. Babbage to the Members of the British Association for the Promotion of Science* London: Richard Clay, 1839.

Babbage wrote a letter of resignation from the BAAS to clear up the "wide misrepresentation of the facts" that led to his leaving an organization of which he had been made a Life Trustee. The title shown is the one Babbage used, but it should have read British Association for the *Advancement* of Science instead of *Promotion*.

(CB 54)

This item was listed by Babbage as "General Plan, No. 25, of Mr. Babbage's great Calculating or Analytical Engine, lithographed at Paris, 1840." Babbage did have such a lithograph made and it was reproduced in the appendix of Henry Babbage's book (1889), but it was never published during Charles Babbage's lifetime. It was not really a paper but one of hundreds of drawings Babbage made for his work on the Analytical Engine.

(CB 55) *Statement of the Circumstances Respecting Mr. Babbage's Calculating Engines* London: Privately printed, 1843

No author was listed on the title page of this item. It was not written by Babbage, although he may have paid to have it privately printed. Best evidence of this is Babbage himself, when he reprinted the item in *Passages* as the main body of Chapter VI, saying:

> The following statement was drawn up by the late Sir Harris Nicolas . . . from papers and documents in my possession relating to the Difference Engine. I believe every paper I possessed . . . on the subject was in his hands for several months (pp. 68–69).

Also, several copies of this rare paper carry a handwritten note on the title page: "by Sir. H. Nicolas" (Sir Nicholas Harris Nicolas, 1799–1848).

54 CB 56 1846 "Description of the Boracic Acid Works of Tuscany," in John Murray, publisher, London, *Handbook for Travellers in Central Italy*, pp. 178–179 London: J. Murray, 1843

A description written by Babbage for Murray's handbook. Title listed incorrectly by Babbage.

		Date	Title	Periodical or Publisher
55	NL in CB	1843	"Addition to the Memoir of M. Menabrea on the Analytical Engine"	*Phil. Mag. 23* (1843), 235–239

In 1842, General L. F. Menabrea published a description of Babbage's Analytical Engine in *Bibliothèque Universelle de Geneve*, 1842, *NS 41*, 352–376. This was translated into English by Lady Lovelace with extensive notes of her own. The entire work[3] was published with the title "Sketch of the Analytical Engine Invented by Charles Babbage, Esq." in Taylor's *Scientific Memoirs* (1843, pp. 666–731), and represents with the translator's notes the most complete description of the Analytical Engine available. The *Phil. Mag.* took note of the contents of Taylor's publication in a short reference on pp. 234–235 of the issue noted above. This note follows:

> The rules prescribed for the publication of the Foreign Scientific Memoirs prevented the Editor from inserting in that work the following authorized statement of the facts connected with the history of Mr. Babbage's Calculating Engines. As those facts may be interesting to our readers, we take this opportunity of communicating them.

From this it would appear that the "Addition" was written by the editors of the magazine. In 1844, however, a German periodical *Astronomische Nachrichten*, edited by H. C. Schumacher (Issue 490), reprinted the "Addition" and attributed it to Babbage by authority of David Brewster, one of the editors of the *Phil. Mag.* Henry Babbage printed this paper in his book (1889, pp. 1–4) using the title "Statement of the circumstances attending the Invention and Construction of Mr. Babbage's Calculating Engines." This should not be confused with CB 55 listed above.

56	CB 57	1847	"Paper on the Principles of Tools for Turning and Planing Metals," in Charles Holtzapffel, *Turning and Mechanical Manipulation*, Vol. 2, Appendix, pp. 984–987	London: Published for the author by Holtzapffel & Co., 1847

Based on extensive observation in machine shops, which was essential to the publication of item 45, this article was written for Holtzapffel's book as a part of the Appendix.

57	CB 49 (CB 48)	1847	*Observations on the Temple of Serapis at Pozzuoli Near Naples*	London: Richard & John E. Taylor (privately printed), 1847

This publication is associated with item 48 (CB 47). As previously noted there, the full paper was read at the Geological Society in March 1834, but the only thing printed at that time was an abstract. It cannot be determined why Babbage would not, or did not, permit the full paper to be produced then, nor is it clear why he returned to it at this late date. In publishing it privately, he added a short piece entitled "Conjectures Concerning the Physical Condition of the Surface of the Moon" (title incorrect in Babbage's list). After the private publication of the paper, the Geological Society did print the full paper on the Temple of Serapis in *Quart. Journ. Geol. Soc. 3* (1847), 186–217. That particular article is the one Babbage lists as CB 48, as if it were a separate item.

At the back of this little volume, there is usually found a list of Babbage's published works, numbered through 46, including this particular item. This was the second publication of such a list, out of four, produced during his lifetime.

58	CB 58	1847	"The Planet Neptune and the Royal Astronomical Society's Medal"	*Times* (London) (15 March 1847), p. 5, col. 4

A letter to the editor complaining that a medal should have been awarded to M. LeVerrier in connection with the discovery of the planet Neptune. Actually, there was considerable controversy as to precisely who first discovered Neptune (Moseley, 1964, p. 198).

59	CB 59	1848	*Thoughts on the Principles of Taxation, with Reference to a Property Tax, and Its Exceptions*	London: J. Murray, 1848

This 24-page pamphlet had a second edition in 1851 with some additions to the text and a third edition in 1852 with a 15-page preface. The first edition was translated into Italian

[3] The editors added a preface that included reference to and quotations from item 49.

and published in Turin in 1850 (not 1851, as Babbage says). Basically, Babbage advocated the introduction of an income tax, with appropriate reductions in other taxes.

60 CB 61 1851 *Laws of Mechanical Notation* London: 1851

This little paper, sometimes accompanied by a lithograph print, was privately published and distributed by Babbage at the Great Exhibition of 1851. He had been greatly disappointed by the exclusion of his Difference Engine from that exhibition and handed out this paper as a way of drawing attention to his work. Actually, it was an incomplete description of Babbage's system and did little to enhance its reputation.

61 CB 63 1851 *The Exposition of 1851; Or Views of the Industry, the Science and the Government of England* London: J. Murray, 1851

A rather vitriolic book continuing Babbage's attack on the place of science in English society. In the opinion of some critics it was less balanced than his 1830 volume on the *Decline of Science* (item 39) and may have been motivated by the exclusion of his machine from the exhibition. One chapter of the book describes the current state of development of the Analytical Engine. A second edition was published in the latter part of 1851, including in the appendix an extract from Charles R. Weld's *History of the Royal Society* (1848) and Augustus DeMorgan's *Review of Weld's History*,[4] both of which dealt with the history of Babbage's work on Calculating Engines. These two writings were factually correct and the comments of Weld and DeMorgan were basically objective. They tended to support Babbage's position. Both editions of the book included the third published list of Babbage's works up through 53 items.

62 CB 62 1852 *Notes Respecting Lighthouses* London: privately printed, 1852

This 24-page paper, containing a description of Babbage's system of occulting lights, has an interesting history. According to Babbage, it was communicated to "the Trinity House" in November 1851 but there is no record of it at Cambridge. In the Parliamentary Papers of 1861, *Reports of the Commissioners, Condition and Management of Lights, Buoys and Beacons*, Vol. 25, there are two pertinent entries. On page 141, there is an indication that the Lighthouse Commissioners considered in November 1851 a suggestion by C. Babbage on a method of illuminating buoys, but his suggestions were not adopted. On page 162, there is (in manuscript form) a letter dated November 21, 1851, from Babbage with notes explaining his system of distinguishing lights by numerals. On the same page, a letter of December 24, 1851, from the Commissioners to Babbage states that they "do not deem it expedient to adopt this system."

In the meantime, Babbage had sent a description of his occulting light system to the United States (*Passages*, pp. 455–457). *U.S. Senate Executive Documents of 1852*, 6 no. 28 (1852), 155, contains a resolution thanking Babbage for his suggestions and states that the Lighthouse Board of the United States has examined them with "great interest" and "will use every endeavor to have a full trial of the method which, in their opinion, promises great advantages to the navigators of the world." There follows a complete reprint of Babbage's paper dated February 5, 1852. This was noted by Babbage in his "list."

The matter was further reported on in the United States by J. H. Alexander in a paper entitled *Experiments on Mr. Babbage's Method of Distinguishing Lighthouses* reported December 26, 1854, to a Committee of the U.S. Lighthouse Board, and printed in 1861 at the Government Printing Office, Washington, DC. From this, it is apparent that some of Babbage's ideas were used in the United States, although they were rejected in his own country.

The printed paper, although dated November 1851, was not published until 1852. It was reprinted in *Mechanics Magazine 60* (1854), 315–318, 363–366, not 1852, as listed by Babbage.

63 CB 60 1852 "Note Respecting the Pink Projections from the Sun's Disc Observed During the Total Solar Eclipse Observed in 1851" *Monthly Notices of the Royal Astronomical Society 12* (1852), 209–210

[4] Reprinted from *The Athenaeum*, London, October 14, 1848.

		Date	*Title*	*Periodical or Publisher*
64	CB 64	1853	"On the Statistics of Lighthouses," in International Statistical Congress, 1st, Brussels, 1853. *Compte rendu des travaux du congrès générale de statistique*, pp. 230–237	Bruxelles: M. Hayes, 1853
			Printed in English. Reprinted in *Mechanics Magazine 60* (1854), 583–585. Not the same as item 62.	
	(CB 65)		Babbage listed an article by T. Wharton Jones in the *British and Foreign Medical Review 14* (1854), 425–432. The article was entitled "Report on the Ophthalmoscope" and makes only brief reference to Babbage's work on the ophthalmoscope.	
65	CB 66	1854	"Mr. Thwaites's Cypher"	*Journ. Soc. Arts*, No. 93 (September 1854), 707–708
66	CB 67	1854	"Mr. Thwaites's Cypher"	*Journ. Soc. Arts*, No. 98 (October 1854), 776–777
			In item 65, Babbage deciphers John Thwaites's cipher published in paper No. 90 of the same journal (August 1854). In paper No. 95, Thwaites claimed that Babbage had not done the deciphering correctly and that his cipher was impenetrable. In item 66, Babbage rebuts Thwaites's response and proves that he had correctly solved the cipher. The titles of these papers were incorrectly listed by Babbage.	
67	CB 68	1855	"Submarine Navigation"	*The Illustrated London News*, No. 749 (23 June 1855), 623–624.
			Based on Babbage's article "Diving Bell" in *Encyclopaedia Metropolitana*, 1826 (item 31).	
68	CB 69	1855	"On the Possible Use of the Occulting Telegraph at Sebastopol"	*Times* (London) (16 July 1855), 6
			A letter to the editor discussing occulting lights for lighthouses and the implied use of the principle by the Russians at Sebastopol. Babbage listed the title of this item incorrectly. Reprinted with additional comment by the editor in *Mechanics Magazine 63* (1855), 57–58 (see item 62 above).	
69	CB 70	1855	"A Method of Laying the Guns of A Battery Without Exposing the Men to the Shot of the Enemy"	*The Illustrated London News*, No. 757 (18 August 1855), 210
			One of the most serious errors in Babbage's list. He says it was published in the *Times* on August 8. He didn't quite get the title right, either.	
70	CB 71 (CB 73)	1855	"Sur la machine suédoise de MM. Schuetz pour calculer les tables mathématiques"	Académie des sciences, Paris, *Comptes rendus hébdomadaires des séances 41* (1855), 557–560
			A description by Babbage of the Swedish Difference Engine successfully built by Messrs. Scheutz (father and son). This Difference Engine was of far simpler design than Babbage's but was based on his writings and research. He applauded it and was pleased when it received the Gold Medal in Paris in 1855 (Morrison and Morrison, 1961, p. xvi). This paper was reproduced in one or two other French periodicals and was described in further detail by Henry P. Babbage in the minutes of the *Proceedings of the Institute of Civil Engineers 15* (1856), 497–514. The paper by Henry Babbage was listed by Charles Babbage as item 73 in his own list of writings. It gave an excellent description of Babbage's system of Mechanical Notation (see note under item 15).	
71	CB 72	1856	"On the Action of Ocean Currents in the Formation of the Strata of the Earth"	*Quart. Journ. Geol. Soc. 12* (1856), 366–368
			A follow-up paper to "Temple of Serapis" (see items 48 and 57).	
72	CB 74	1856	"Analysis of the Statistics of the Clearing House During the Year 1839"	*Journ. Stat. Soc. 19* (1856), 28–48
			This item, which was incorrectly titled by Babbage in his list, was also separately printed with a title page and an appropriate binding. In this form it contained 33 pages of text and 14 pages of tables, plus an appendix.	

185

73	CB 76	1856	*Observations Addressed at the Last Anniversary to the President and Fellows of the Royal Society after the Delivery of the Medals*	London: John Murray, 1856

This paper concerned Scheutz's Calculating Machine, describing the minor differences in design from Babbage's concept. It was reprinted in the *Mechanics Magazine 64* (1856), 343–346, under the title "The Calculating Machine of M. Scheutz."

74	CB 77	1857	"Table of the Relative Frequency of Occurrence of the Causes of Breaking of Plate Glass Windows"	*Mechanics Magazine 66* (1857), 82

Not signed by Babbage but listed in the periodical as "prepared by an eminent statistician." Babbage listed 464 instances of "broken glass windows" as reported in the *Times* and gave a statistical breakdown of the causes.

75	CB 78	1860	"Observations on the Discovery in Various Localities of the Remains of Human Art Mixed with the Bones of Extinct Races of Animals"	*Royal Society of London, Proceedings 10* (1860), 59–72

Babbage gives an incomplete title for this item and the wrong year of publication (1859).

76	NL in CB	1864	"A Chapter on Street Nuisances"	London: J. Murray, 1864

Although this is an "extract" from item 77, which follows, it deserves status as a separate paper. It was published well in advance of the book in which it appeared, and had a second edition shortly thereafter, both published by Murray; the third edition was published in 1864 by Longman & Co., who also published the book.

In the letter part of his life, Babbage felt plagued by street musicians, organ grinders, and the like. He became notorious for his behavior toward these individuals, which may explain why three editions of this paper were necessary to satisfy public demand.

77	CB 79	1864	*Passages from the Life of a Philosopher*	London: Longman, Green, Longman, Roberts & Green, 1864

This well-known book is a partial autobiography by Babbage and makes fascinating reading, but it leaves out any reference to his family and deals only superficially with Lady Lovelace. It does give helpful insights to the character of the author and contains the final list of printed papers that this article attempts to correct. The book was reprinted in 1968 by Dawsons of Pall Mall in London and that reprint was distributed in the United States by Augustus M. Kelley in 1969.

78	NL in CB	1865	*Thoughts Upon an Extension of the Franchise*	London: Longman, Green, Longman, Roberts & Green, 1865

A pamphlet that attempts to relate voting rights to Babbage's thoughts on the principles of taxation expressed in item 59. Published after his last "list."

79	NL in CB	1868	"Observations on the Parallel Roads of Glen Roy"	*Quart. Journ. Geol. Soc. 24* (1868), 273–277

Babbage's last published paper. Reference is made to the theory of isothermal forces within the earth as demonstrated at the *Temple of Serapis* (see items 48 and 57).

(CB 80)

As his last item, Babbage listed as being "in the press" a book to be entitled *History of the Analytical Engine*. Undoubtedly, he started work on it, for its proposed contents form the basis for Henry P. Babbage's volume *Babbage's Calculating Engines* published by E and F. N. Spon in 1889.

Anecdotes

Policy. Anecdotes about people, companies, computers, and languages are welcome. The stories should involve some specifics—dates, names, places—and should be interesting—obviously a highly subjective judgment, but one that we hope is flexible. We want to avoid libel, but controversy is appropriate.

—Calvin C. Gotlieb

Napier and Babbage

The following is an excerpt from the Inaugural Address by Lord Moulton, entitled "The Invention of Logarithms—Its Genesis and Growth," given at the International Congress, which met in Edinburgh toward the end of July 1914 to commemorate the tercentenary of the publication of John Napier's *Mirifici Logarithmorum Canonis Descriptio.* It is printed on pages 19 and 20 of the *Napier Tercentenary Memorial Volume,* published for the Royal Society of Edinburgh by Longmans, Green and Company, London, 1915.

I have now given you, as I read it, the line of discovery which led up to Napier's Table of Logarithms which was published in the *Descriptio.* That which impresses me most deeply is his tenacity of aim, combined with his receptivity of new ideas in attaining it. From first to last it was a Table of Logarithms of sines that he proposed to make and he did not permit himself to be turned aside from that purpose till it was accomplished. His concepts evidently widened as he proceeded, and he must have been sorely tempted to turn from his comparatively restricted task to larger schemes. But he wisely resisted the temptation. He saw that he must create an actual table and give it to the world, or his task was unperformed. Would that other inventors had been equally wise! One of the sad memories of my life is a visit to the celebrated mathematician and inventor, Mr. Babbage. He was far advanced in age, but his mind was still as vigorous as ever. He took me through his workrooms. In the first room I saw the parts of the original Calculating Machine, which had been shown in an incomplete state many years before and had even been put to some use. I asked him about its present form. 'I have not finished it because in working at it I came on the idea of my Analytical Machine, which would do all that it was capable of doing and much more. Indeed, the idea was so much simpler that it would have taken more work to complete the Calculating Machine than to design and construct the other in its entirety, so I turned my attention to the Analytical Machine.' After a few minutes' talk we went into the next work-room, where he showed and explained to me the working of the elements of the Analytical Machine.

Continued on page 187.

Comments, Queries, and Debate

Policy. We expect that articles published in the *Annals* will generate debate, inasmuch as they reflect the views and historical perspective of the authors.

This department offers the opportunity for correction and/or completion of the historical record. Also welcome are queries on historical events or facts, which will stimulate comments and perhaps further debate. Only material that is relevant and in good taste will be used. Supporting references are strongly encouraged.

—Frank Wagner

Comments from Konrad Zuse

Konrad Zuse wrote the following letter to Cuthbert C. Hurd on June 18, 1979. In it he mentions two works reviewed in the *Annals:* his own *The Plankalkül* (1976), reviewed in Volume 2, Number 1, January 1980, pages 89–90, and Czauderna's *Konrad Zuse* (1979), reviewed in this issue on pages 187–189. Because Zuse is truly a giant in the history of computing, and because his thoughts on his early work are so important, we are especially pleased to publish his letter.

Dear Mr. Hurd,

Thank you for your letter dated May 15, 1979. I am very pleased with your interest in my developments in the computer field.

Some days ago I got the first number of the *Annals.* I am studying it with great interest.

Concerning the article about the History of Programming Languages Conference, I would like to call your attention to my early work (1945) on the "Plankalkuel." By separate mail I shall send you a copy. I hope that you will find the time to have a look at it and to see that nearly all features of modern algorithmic languages were already elaborated in this language. Unfortunately, in 1945 nobody in the world was interested in it. About ten years later, when algorithmic languages were of immediate interest, attention first focused on numerical problems, and almost nobody saw the necessity of a language based on applied mathematical logic. At that time it seemed to be—in some sense—lunatic to test the general usefulness of a programming language by applying it to chess problems.

I hope to find time to discuss these problems in your *Annals.*

Meanwhile, the German version of my paper "The Installation of the German Computer Z4 in Zurich in 1950" has been published in ZAMP (*Journal of Applied Mathematics and Physics,* Vol. 30, 1979). The same volume contains an interesting paper of Professor Ambros Speiser, also referring to the model Z4, "Digital Proc-

essing: Reflections About the Past and the Future." This article, too, may be of interest to you and you may contact Mr. Speiser.

Further, I would like to call your attention to the book by Karl-Heinz Czauderna, *Konrad Zuse, der Weg zu seinem Computer Z3* (Bericht 120, Gesellschaft für Mathematik und Datenverarbeitung, R. Oldenbourg Verlag), and would like to ask you if the translation (perhaps partly) of this book into the English language may be of interest to you. I shall send you a copy of it by separate mail.

Perhaps you could also contact my friend Professor Dr.-Ing. H.-Th. Schreyer (Rio de Janerio - Santa Teresa, Brazil). I guess he was the first man in the world who had the idea to construct a computer in electronic technology (beginning about 1936). Professor Arthur W. Burks of the University of Michigan may give you some further information.

Cordially yours

On Randell's Bibliography

The following is an excerpt from a letter dated December 3, 1979, from Robert Bigelow, Editor, *Computer Law Service*, concerning the Randell bibliography (*Annals*, Volume 1, Number 2, October 1979, pp. 101–207):

Commenting on Brian Randell's superb bibliography in the October issue of the Annals.... in Appendix 2 at page 190, he cites the case of Honeywell v. Sperry Rand. The full text of this opinion is available publicly in 180 U.S.P.Q. 673; an abridged version is also published at 5 CLSR 78. Both of these case reporters are available in most large law libraries.

***Anecdotes**, continued*

I asked if I could see it. 'I have never completed it,' he said, 'because I hit upon an idea of doing the same thing by a different and far more effective method and this rendered it useless to proceed on the old lines.' Then we went into the third room. There lay scattered bits of mechanism, but I saw no trace of any working machine. Very cautiously I approached the subject, and received the dreaded answer, 'It is not constructed yet, but I am working at it, and it will take less time to construct it altogether than it would have taken to complete the Analytical Machine from the stage in which I left it.' I took leave of the old man with a heavy heart. When he died a few years later, not only had he constructed no machine, but the verdict of a jury of kind and sympathetic scientific men who were deputed to pronounce upon what he had left behind him, either in papers or mechanism, was that everything was too incomplete to be capable of being put to any useful purpose.

Harry Nagler
190 Riverside Drive
New York, NY 10024

nals of
History of
puting
2, No. 2
1980

Reviews

The Reviews section features extended reviews of selected publications. Most reviews are solicited, but colleagues are invited (and indeed encouraged) to participate in this reviewing activity by indicating their wish to review a work, by suggesting titles to the Reviews editor, or by submitting a manuscript. In the latter instance please consult with the editor to avoid duplication. All books, monographs, journal articles, films, videotapes, and other publications relating to the history of computing will be described briefly in the Capsule Reviews section. Comments on books, articles, or reviews should be submitted to the Letters department. NB: Reviews without bylines are by the editor. —*Henry S. Tropp*

Konrad Zuse, the Path to His Computer Z3 (*Konrad Zuse, der Weg zu seinem Computer Z3*). By Karl-Heinz Czauderna (in German). Report 120, Gesellschaft für Mathematik und Datenverarbeitung. Munich: R. Oldenbourg, 1979, 105 pp.

Konrad Zuse is a remarkable man. In the isolation of Nazi Germany before and during World War II, he conceived, developed, and in 1941 completed the Z3, which appears to have been the first functioning program-controlled computer. He was driven by his inventiveness and a clear recognition that the repetitious desk-calculator operations required by his engineering job could be automated. Although Zuse would eventually establish his own computer company, which manufactured and sold relay, tube, and transistor computers with some success, he lost momentum in the physical and economic disaster of the war. Parallel developments in the United States, performed without knowledge of Zuse's work, were spurred by a postwar boom. Thus, fate prevented Zuse's pioneering effort from making its potential impact.

Karl-Heinz Czauderna is a recent engineering graduate who became fascinated by Zuse and wrote this account of Zuse's early work as a thesis. The book contains a brief biography and extensive material describing and giving the technical background of Zuse's first three computers: the Z1, an entirely mechanical device completed in 1938, the Z2, a relay protoype built in 1939 that retained the mechanical memory of the Z1, and the Z3, made entirely of relays and completed in

1941. The author also includes reminiscences of several of Zuse's coworkers and friends who helped him financially and manually to construct these machines, largely in the basement and living room of Zuse's parents.

The biographical part consists of four pages of text, three photos, and two more pages summarizing Zuse's work after the Z3. It is basically a summary of Zuse's autobiography, *The Computer, My Life's Work (Der Computer mein Lebenswerk*, Munich: Verlag Moderne Industrie, 1970). Anyone interested in the man, his background, and the line of reasoning that led to his inventions should look for the original; Zuse did a much better job himself.

The bulk of Czauderna's book is devoted to technical matters. The author drew not only on Zuse's own briefer account ("Lines of Development of a Computer from Mechanics to Electronics," in *Digital Information Processors* (W. Hoffmann, ed.), New York: Interscience Publishers, 1962), but also on publications by Zuse's company, patent applications, and personal contact with Zuse. This book may be the most accessible description with sufficient detail to satisfy a technical reader.

The Z1 and Z3, although physically very different, were logically the same. Remarkably, they were floating-point, binary machines. Zuse was driven to this choice by a severe constraint on money and material. He devised the floating-point representation to obtain a wide range of numbers with a minimum of bits. He chose binary numbers because on-off relays, in one form or another, were cheaper and easier for him to obtain than decimal counter wheels.

Programs were punched on eight-channel tape, made from old 35-mm movie film rather than the familiar paper tape; homemade devices punched and read the film. Each tape frame was one eight-bit instruction. The memory held 64 words (floating-point numbers) of 22 bits: one sign bit, seven bits for the exponent, and fourteen bits for the mantissa. The fetch and store instructions used six instruction bits as an address. The other instructions had no address and performed normalized floating-point arithmetic on previously fetched operands: addition, subtraction, multiplication, division, and square root.

Instructions were executed sequentially as read from the tape. Programs could not be stored internally, and hence there was no branch instruction. Zuse apparently considered the possibility of storing the program but rejected it because of the complexity and cost of the extra storage bits required.

Input/output was primitive: keys and lights for four decimal digits and a sign, and several keys and lights to indicate the decimal-point position. Decimal-binary conversion was performed automatically by the machine. Additional keys permitted use as a desk calculator by entering one of the arithmetic operations. An illustration in the book also shows an "i" (imaginary) key, but its exact function is left to the reader's imagination.

To design these complex machines, Zuse developed his own version of Boolean algebra. Without this systematic attack, he might never have been able to complete his projects with limited means.

In this connection, it is interesting to note why Zuse started with a completely mechanical computer, the Z1. He had relays in mind when he chose binary logic and numbers, but he decided that the thousands of electric relays needed would exceed his financial and space limitations. So he devised a mechanical analog of the relay and fabricated it out of sheet metal. This relay was used for logic. Zuse also developed a mechanical storage array and address decoder that, because of the regularity and thin sheet-metal construction, proved compact and reasonably reliable. Czauderna describes these devices in some detail.

Although the Z3 is considered Zuse's real pioneering contribution, the complex sheet-metal structure of the earlier Z1 is in some ways more amazing. Czauderna quotes one of Zuse's coworkers: "I . . . did not know exactly how this monster, which was being created, would eventually work. Nonetheless, the machine, once complete, worked with an unholy clatter and gave the exact solutions to complicated problems. It occupied almost the entire living room. It could no longer be moved out of the house." The Z1 was abandoned because the logic part was too unreliable, and Zuse turned to electric relays.

Because the design of the Z1 was laid out in Boolean logic, it was simple for Zuse to build its electric counterpart, the Z3, with 2600 used telephone relays. The Z1 and Z3 computers and the Z2 prototype were all destroyed in 1944 during a bombing attack on Berlin. Only a later improved version, the Z4, remained and was put to productive use after the war.

Czauderna's book is somewhat marred by misprints, which may hinder a reader not too familiar with computers or with the German language.

One might have wished for more of a technical perspective, relating Zuse's accomplishments to later developments, but that may be too much to expect from a student thesis. The book does contain enough to give the reader a good impression of Zuse's pioneering work.

Werner Buchholz
IBM Corporation
Poughkeepsie, NY 12602

Capsule Reviews

■ Williams, M.R. 1979. The difference engines. *The Computer Journal 19*, 1, 82–89.

The article covers some of the same nineteenth-century machine developments as the monograph above, but with a slightly different emphasis. This survey begins with a discussion of the beginnings of large-scale production of mathematical tables and the proposal (in 1786) by J. H. Müller to construct a difference engine that would print its results. In addition to the more famous engines, which are also discussed by Merzbach, Williams mentions some machines that were of secondary importance, such as the tandem Brunsviga machines designed by A. J. Thompson, and discusses Comrie's adaptation of accounting machines for table construction prior to World War II.

■ Hoopes, James. 1979. *Oral History: An Introduction for Students*. Durham: University of North Carolina Press, 155 pp., $10.

This volume appears to be a very nice, concise, informative text aimed primarily at students interested in using oral research along with other standard research techniques. It can be valuable to readers of this journal, because oral history is an important facet of contemporary studies in the history of computing. In particular, the author deals with the mechanics of interviewing (arranging for the interview, background preparation, conduct of an interview, etc.) along with some of the legal and ethical problems surrounding oral studies. Additionally, there is a limited but broadly based bibliography of source materials.

■ Mauchly, John W. 1979. Amending the ENIAC story. *Datamation 25*, 11, 217–219.

In this lengthy letter to the editor, John Mauchly addresses the "priority" controversy surrounding the origin of the "stored program concept." His account of the environment at the University of Pennsylvania's Moore School during the construction of ENIAC and the conceptual development of EDVAC leads to his conclusion that this significant concept evolved naturally as the ENIAC crew realized ENIAC's shortcomings and began to think of what the next computer ought to be like. Mauchly makes the point that this conceptual architectural notion evolved long before von Neumann's first visit to ENIAC in September 1944 and that it is not possible 35 years later to establish who "first" thought of it. (This in no way diminishes the importance of von Neumann's contributions to early computer developments or the critical impact of his famous EDVAC report: John von Neumann, "First Draft of a Report on EDVAC," University of Pennsylvania, 30 June 1945.)

In addition to his comments on ENIAC and EDVAC, Mauchly also cites documents recording that "one side" of BINAC ran for 44 continuous, error-free hours in April 1949. (EDSAC, at Cambridge, recorded its first "run" in May 1949.)

Editor's Note: Conflict over priorities can often sidetrack historical research and deflect scholarly research on broader issues. This may be a good occasion to quote the late Kenneth O. May on the subject of "priorities" (*Bibliography and Research Manual of the History of Mathematics*, University of Toronto Press, 1973, p. 29):

> It is soon apparent to the historian that people often do not get the credit they deserve. . . . Questions of priority are worthy of historical consideration only when they involve historical issues, not merely efforts to dispense justice. Moreover, the question of who did something "first" usually turns out to be meaningless because of the unremovable ambiguities in the definition of the "something" and what is meant by "doing" it. . . . The seeds of ideas must come before the ideas themselves!

■ *Scientific American*. 1978. *Mathematics: An Introduction to Its Spirit and Use* (with an Introduction by Morris Kline). W.H. Freeman & Company, San Francisco.

This new collection of *Scientific American* reprints contains a section entitled "Symbolic Logic and Computers." Of particular interest is John E. Pfeiffer's "Symbolic Logic" (December 1950) and the late Louis Ridenhour's "The Role of the Computer" (September 1950). The first contains a brief discussion of Edmund Berkeley's pioneering paper (1936) and his small "mechanical brain"

known as Simple Simon (November 1950); the second includes nice-sized photographs of Typhoon (an RCA analog computer) and a panel from one of the Bell Labs relay computers. Additionally the article on Leibniz (Frederick C. Krieling, May 1968) contains two high-quality photographs of reproductions of a Leibniz calculating machine in the Deutsches Museum in Munich. A 1968 collection of *Scientific American* readings, "Mathematics in the Modern World," contains the following articles of historical interest: Harry M. Davis, "Mathematical Machines" (April 1949—difference engine, differential analyzer, relay computers, ENIAC, SSEC, etc.); Stanislaw M. Ulam, "Computers" (September 1964); and Norbert Wiener, "Cybernetics" (November 1948).

■ Dorn, Phillip H. 1979. COBOL's original players. *Datamation 25*, 8, 55.

A very nice report on the NCC 79 Pioneer Day program commemorating the 20th anniversary of COBOL. Included is a group picture of the COBOL pioneers who participated in the formal program: Grace Hopper, Jean Sammet, Betty Holberton, Howard Bromberg, Jack Jones, Charles Phillips, and Norm Discount.

■ Garner, Harvey L. 1979. "Computing in China, 1978," *IEEE Computer 12*, 3, 81–96.

This paper is a description of a visit to China by an IEEE Computer Society delegation in September 1978 and includes the author's assessment of Chinese computer technology. As Garner points out, the 20-year history of digital computation in the People's Republic of China cannot be discussed "without noting the decade encompassing the Cultural Revolution (1966–1976) and the activities attributed to the 'Gang of Four.' Available information is not adequate to allow us to determine the effects of the strife and change of this period on the development and use of computers.... One obvious product of this period is the neighborhood factory... [such as] the 'Door Handle Factory' (where C-2 and 709 Computers were built) and the 'Torch Semiconductor Factory' (where IC's are built)...." The author has put together a very good summary of Chinese computer developments in the past two decades, including a table listing some of the known computers and their basic characteristics as well as his sources of information. The majority of these sources are unpublished reports by individuals and delegations of various trips to China beginning in 1973. Despite the difficulties involved in gathering historical information on Chinese computer developments, papers of this nature are likely to remain our only source for some time. As Garner says, "It is likely that insufficient knowledge of the details of computer development exists even in China. If the history is to be written, it will have to be written by the Chinese, and they have more pressing problems at present." In addition to hardware developments, the author also briefly discusses various university activities, software, high-speed memory technology, peripheral equipment, integrated circuits, and production methodology. The paper concludes with a list of the questions that were asked of members of the delegation by Chinese technologists.

■ Merzbach, Uta C. 1977. "George Scheutz and the First Printing Calculator." Smithsonian Studies in History and Technology, No. 36. Washington: Smithsonian Institution Press.

The excellent monograph does much more than merely recount the accomplishment of George Scheutz and his son Edward in demonstrating the feasibility of Babbage's concept of a machine capable of both performing computations and printing the results. The account includes not only important information on the individuals involved in promoting and realizing mechanical computational capability in the nineteenth century, but also primary source information on their political difficulties in obtaining public support for their machines. I saw and learned much for the first time in the pages of the monograph—both in the text and in some of the photographic illustrations: details of the Scheutz calculator (nine photographs), a sample printout of a computation done on the calculator during its operation in Albany at the Dudley Observatory, the Scheutz-Donkin calculator (Scheutz #2), the Wiberg difference engine, and the Grant difference engine (at the Philadelphia 1876 Centennial Exposition).

In addition to the excellent bibliography, the monograph also includes three appendixes: the British patent issued to George and Edward Scheutz in 1855 (filed in 1854); an abstract by William Garatt on how the engine worked; and a translation (by the author) of a "Discussion at the Academy of Science, Paris" that appeared in *Cosmos 13*, 1858. This volume is an excellent source for individuals interested in nineteenth-century computational developments.