

Who Invented the Computer?

When originally presented, this lecture was part 1 of a two part series. The second part covered the story of early electronic computers in the mid-twentieth century. This handout includes references for both parts, so if you are interested in the latter story, some interesting references are provided.

Part 1: 19th Century Roots

Primary Sources

Sketch of The Analytical Engine Invented by Charles Babbage; by L.F. Menabrea of Turin, Officer of the Military Engineers, from the Bibliothèque Universelle de Genève, October, 1842, No. 82; Translation originally published in 1843 in the Scientific Memoirs, 3, 666-731; With notes upon the Memoir by the Translator, ADA AUGUSTA, COUNTESS OF LOVELACE

Ada Lovelace's translation of Menabrea's paper on the Analytical Engine. Available as a free download from various online sources, including:

https://johnrhudson.me.uk/computing/Menabrea_Sketch.pdf

<https://www.fourmilab.ch/babbage/sketch.html>

Passages from the Life of a Philosopher; Charles Babbage, originally published in London, by Longman, Green, Longman, Roberts, & Green in 1862.

Not a typical autobiography, but a very interesting read. An online review by "Gabriel" at <https://www.goodreads.com/book/show/2627810-passages-from-the-life-of-a-philosopher> sums it up well, in my opinion:

The rambling autobiography of a fascinating man. Three parts hilarious anecdotes, two parts ranting, one part science, one part crusade against street music, and one bizarre chapter in which Babbage communes with a piece of cheese. Gloucester cheese, to be exact.

I would offer one correction to Gabriel's review; Babbage communes with the soul of a mite residing within that piece of cheese, not the piece of cheese itself.

Readily available in various print and ebook editions from Amazon and other online booksellers. Also available as a free download at <https://www.gutenberg.org/ebooks/57532>, or <https://standardebooks.org/ebooks/charles-babbage/passages-from-the-life-of-a-philosopher>

Ada's Algorithm: How Lord Byron's Daughter Ada Lovelace Launched the Digital Age; James Essinger; Published by Melville House in 2014; ISBN-10: 1612194575; ISBN-13: 978-1612194578

A nice biography of Ada Lovelace, available from Amazon and other online sources in hardcover and paperback. Had been available for Kindle (that's what I have), but now no longer seems to be available in that format. A second edition with new material is due to be published in paperback, available on Amazon October 11, 2022.

Untangling the Tale of Ada Lovelace; Stephen Wolfram; Article in Wired, December 22, 2015:
<https://www.wired.com/2015/12/untangling-the-tale-of-ada-lovelace/>

A shorter, but fact-filled biography of Ada Lovelace (though long for a magazine article) by a renowned scientist, also including a fair amount of information about Charles Babbage.

The Thrilling Adventures of Lovelace and Babbage; Sydney Padua; Published by Pantheon Books, New York, 2015; ISBN 978-0-307-90726-8 (hardcover, alk paper), ISBN: 978-0-307-90838-5 (eBook)

A graphic novel telling the story of Charles Babbage, Ada Lovelace, and the invention of the Analytical Engine, as well as a number of fictional accounts of how it might have been put to use by the two of them in a parallel universe where it had actually been built. Written to amuse, it is simultaneously ridiculous and well researched. It is replete with footnotes and endnotes describing actual events in the lives of Lovelace and Babbage.

Available in paperback, hardcover, and Kindle editions from Amazon. I'm not sure I would recommend the Kindle edition, as the graphics are key to this book. While new copies seem to be reasonably pricey, used hardcover or paperback copies are available for less.

Other Sources

There is much written on Charles Babbage and Ada Lovelace easily located with obvious Google searches (e.g., by searching their names). A couple of online papers I found interesting are:

Ada Lovelace, Charles Babbage, and the Impact of Social Class; Christopher D. Green, York University; <http://www.yorku.ca/christo/papers/babbage>

The Lovelace-De Morgan mathematical correspondence: A critical re-appraisal; Christopher Hollings, Ursula Martin, Adrian Rice; Published by *Historia mathematica*, Volume 44, Issue 3, August 2017, pages 202-231; Available online at:
<https://www.sciencedirect.com/science/article/pii/S0315086017300319>

Lovelace and Babbage – Period Documents; A treasure trove of links to historical documents by and about Ada Lovelace and Charles Babbage, their lives and times. Compiled and annotated by Sydney Padua, author of *The Thrilling Adventures of Lovelace and Babbage*;
<https://www.diigo.com/outliner/4232ob/Lovelace-and-Babbage-Period-Documents?key=egouoj2gks;>

You can get lost in here for days at a time. Also see Sydney Padua's web page about her book: <http://sydneypadua.com/2dgoggles/>

Video

Videos included in the presentation, and a few other interesting ones:

False Dawn: The Babbage Engine; video included in presentation; <https://www.youtube.com/watch?v=XSkGY6LchJs>

A demo of Charles Babbage Difference Engine; A 24-minute presentation by a docent at the Computer History Museum leading a demonstration of the museum's Difference Engine, with an informative explanation of its workings; <https://www.youtube.com/watch?v=BlbQsKpq3Ak>

How an 1803 Jacquard loom Led to Computer Technology; a portion of this video was included in the presentation; <https://www.youtube.com/watch?v=MQzpLLhN0fY>

Paradise Mill How The Jacquard Mechanism Works; a more detailed description about how a Jacquard loom works; https://www.youtube.com/watch?v=x_ijmJx7Xys

Babbage's Analytical Engine: Overview; animated explanation of how the Analytical Engine works, created and presented by Sydney Padua, author of *The Thrilling Adventures of Lovelace and Babbage*; <https://www.youtube.com/watch?v=fyUtU6LVNY>

Mission Impossible: Constructing Charles Babbage's Analytical Engine; 1.5 hour long lecture by Doran Swade about Babbage, his engines, and early plans on building a working Analytical Engine (as the Difference Engine #2 was previously built); <https://www.youtube.com/watch?v=lnFe4UUE4KM>; This lecture was given in 2012, but it seems the project to build an Analytical Engine lives on, as described at <https://plan28.org>.

Part 2: 20th Century Results

Primary Sources

On Computable Numbers, with an Application to the Entscheidungsproblem; by A. M. Turing, 28 May 1936; Published in *Proceedings of the London Mathematical Society*, Volumes 2-42, Issue 1, 1937, pages 230-265. Available at <https://doi.org/10.1112/plms/s2-42.1.230>

Alan Turing: The Enigma; by Andrew Hodges, 1983; First published by Burnett Books, Ltd., in association with Hutchinson Publishing Group, 1983; New edition with updated preface by Andrew Hodges published in 2014 by Vintage Random House, a Penguin Random House Company; ISBN 978-0-691-16472-4; widely available from Amazon or other booksellers. This is the definitive biography on the life and works of Alan Turing, and source for the 2014 movie, *The Imitation Game*

First Draft of a Report on the EDVAC; by John von Neumann; Moore School of Electrical Engineering, University of Pennsylvania, June 30, 1945; retyped by Michael D. Godfrey into TEX word processing system, from original typed copies, with obvious typos and other errors corrected; published in *IEEE Annals of the History of Computing*, Vol. 15, No. 4, pages 27-75, 1993. Available as a downloadable PDF file at <https://history-computer.com/Library/edvac.pdf>.

The Computer from Pascal to von Neumann; by Herman H. Goldstine, 1972, Princeton University Press; Fifth paperback printing, with a new preface by H.H. Goldstine, 1993; ISBN 0-691-02367-0; available from Princeton Press, Amazon or other booksellers. New paperbacks are quite pricey, but reasonably priced used copies are currently available through Amazon. As its name implies, this book includes a lot of history of the early development of computing machines. Of particular note are the first-hand accounts of the ENIAC, EDVAC, and IAS computer projects overseen by the author.

An Interview with J. Presper Eckert; Conducted by Nancy Stern on 28 October 1977 at Sperry Univac (Blue Bell, PA); published by Charles Babbage Institute, Center for the History of Information Processing, University of Minnesota, Minneapolis. Lengthy and fascinating oral history interview covering much of the history of ENIAC and EDVAC developments at the Moore School of Electrical Engineering from a plain spoken participant. Available at: <https://conservancy.umn.edu/bitstream/handle/11299/107275/oh013jpe.pdf>

Other Sources

The Annotated Turing; by Charles Petzold, 2008, Wiley Publishing, Inc.; ISBN 978-0-470-22905-7; widely available from Amazon or other booksellers. The subtitle of this book is, “A Guided Tour

through Alan Turing's Historic Paper on Computability and the Turing Machine." That sums it up pretty well. The book includes the full text of Turing's 1936 paper, with commentary about virtually every paragraph and often each sentence. It provides concrete examples and thorough explanations to make this difficult paper more approachable. It also includes a bit of historical information. While fully understanding everything in the original paper is still a challenge, it is much more achievable with this well written text as a backup.

Von Neumann Thought Turing's Universal Machine was 'Simple and Neat.': But That Didn't Tell Him How to Design a Computer; by Thomas Haigh, Mark Priestley; Communications of the ACM, Vol. 63, No. 1, January 2020, Pages 26-32; An interesting article in a leading Computing Science academic journal comparing the contributions made by Alan Turing and John von Neumann to the invention of the computer. The article makes only a passing acknowledgment of the controversy of whether von Neumann or Eckert, Mauchly, et. al., deserve credit for the architecture presented in the First Draft report.

Video

On computable numbers, with an application to the Entscheidungsproblem – Papers we Love #011; YouTube video at <https://www.youtube.com/watch?v=g5yRQ77borA> featuring Melvin Zhang lecturing about Alan Turing's paper; 42 minutes. Helpful explanation of the background and contents of Turing's paper.

1x08 – Kyle Geske – On Computable Numbers; Another YouTube video, at <https://www.youtube.com/watch?v=PMdN3N9LhB0> featuring Kyle Geske lecturing about Alan Turing's paper; 51 minutes. Another take on explaining the paper, with a bit more detail about Turing Machines.

Who Invented the Computer?; a short YouTube video at <https://www.youtube.com/watch?v=d1pvc9Zh7Tg> that takes on the title question, and answers it in 5 minutes (*now he tells us!*). With a conclusion that there is no one person that can be identified, it seems reasonable enough. Inexplicably, though, it makes no mention of John von Neumann, often the first name mentioned in similar discussions.

Turing Machine Simulator

Turing Machine Visualization; an interactive web site at <https://turingmachine.io> that allows the definition of arbitrary Turing Machines to be simulated with a graphical visualization of the running process. Used in the presentation for the “divide by 5” Turing Machine example. The source code for the example Turing Machine may be downloaded from:

<https://gist.github.com/DavidMcKinley1/381aa291d3b04db68c592413b765fbc>,

Or automatically imported into the Turing Machine simulator by going to URL:

<https://turingmachine.io/?import-gist=381aa291d3b04db68c592413b765fbc>