

Charles Babbage: Part 2

Babbage's Analytic Engine

James Tam

Babbage's Analytic Engine: Background

- Recall:
 - While Babbage was working on the Difference Engine, often a lack of funding halted work.
 - One time it was so drastic that work halted entirely.
 - When work re-started Babbage and Clement had a dispute over Clement's new working conditions.

Babbage



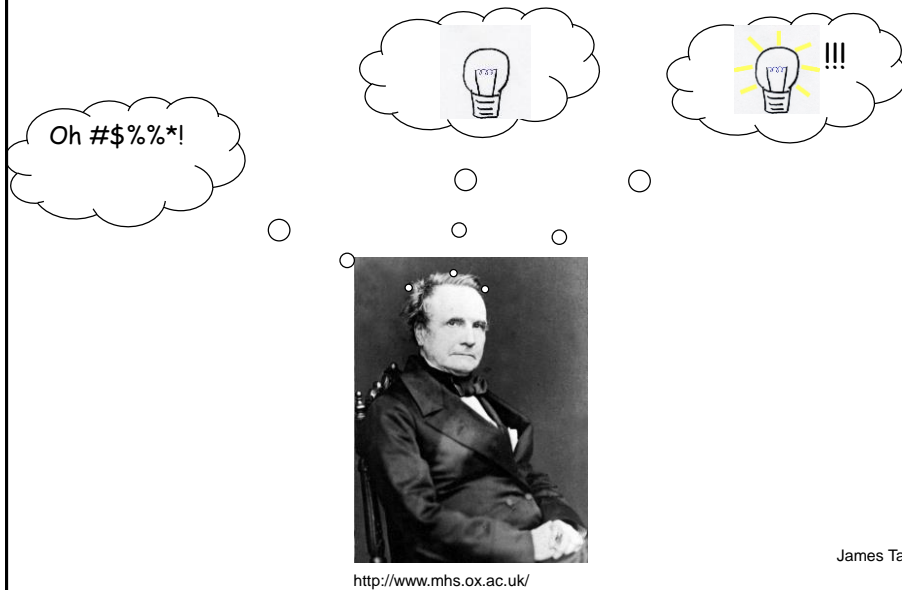
Clement



www.colorbox.com

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Babbage's Analytic Engine: Background



Babbage's Analytic Engine: Significance

- The Difference Engine was an important step in the development of computation.
- The Analytic Engine ushered in an entirely new and critical concept: a computing machine that was controlled by an external program. ("A programmable device!")
- Earlier devices were physically created to perform a specific task.
 - Either: a major design, or a completely new design would be needed to perform different functions.

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Babbage's Analytic Engine

- It's difficult to determine the exact operation of the Analytic Engine:
 - Not completed (re-created from complex diagrams)
 - Many iterations continuously produced (right up to Babbage's passing)
- A re-creation (based on the snapshot of the original machine in 1840) was produced under the direction of Major-General H.P. Babbage (1906) – the son of Charles Babbage.



"A History of Computing Technology" (Williams)

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Components Of The Analytic Engine

- Store
- Mill
- Control Barrel
- Counter Mechanism

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Analytic Engine: Implementation Of The Store

- Information was stored in registers in the form of gears.
- Each gear was used to represent a single digit and it could rotate to 10 different positions .
- Different source writings specified different storage capacities:
 - Source 1: 100 forty digit numbers.
 - Source 2: 1000 fifty digit numbers.

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Analytic Engine: Implementation Of The Mill

- An extremely complex arrangement of gears and linkages between the gears was employed.
- Operations:¹
 - 4 basic mathematical operations (addition, subtraction, multiplication, division), logical comparisons, and computing square roots was an option.
- To understand the relationship between the mill and store a weaving metaphor may be used.¹
 - Store: the location where numbers are held (value stored = a pattern in the cloth).
 - Mill: the location where numbers are 'woven' into their new patterns based upon the operation to be performed.

¹ Source: <https://turing.plymouth.edu/~zshen/Webfiles/notes/CSDI1400/note2.pdf>

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Analytic Engine: Implementation Of The Control Barrel

- Similar to a old-time music box but instead of storing melody this control barrel would store microcode instructions.
- Reference website from IBM (note they use the term 'firmware' rather than 'microcode'):
 - <https://www.ibm.com/think/topics/firmware#:~:text=Firmware%2C%20also%20known%20as%20%E2%80%98software%20for%20hardware%2C%E2%80%99%E2%80%99%20is,enable%20them%20and%20their%20features%20to%20function%20properly.>

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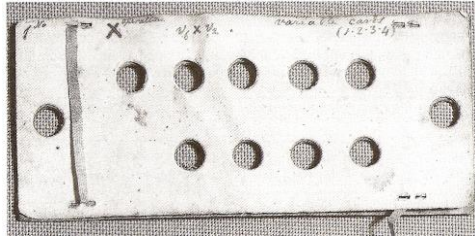
Babbage's Analytic Engine: Significance #1

- Babbage merely conceived of the Analytic Engine as an academic exercise rather than having the goal of producing a model to be used to solve actual problems.
- Significance (Metrics from Williams): Speed/advanced technology
 - Although slow by today's standards the Analytic Engine was far in advance of it's time.
 - Addition time, Analytic Engine: (3 seconds, 1 second with later version, ~1830- 1871)
 - Addition time, Harvard Mark I: 0.3 second ~World War II (1939 – 1945)

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Babbage's Analytic Engine: Significance #2

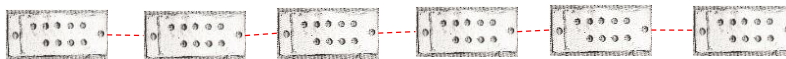
- Significance: it included the concept of a stored program
- Instructions for the Analytic Engine were to be stored on a series of punched cards.



"A History of Computing Technology" (Williams)

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Babbage's Analytic Engine: Significance #2 (2)



Example loop 'body'

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Images: "A History of Computing Technology" (Williams)

Did Babbage Ever Build An Analytic Engine?

- He viewed the design process as an academic exercise.
- Some parts were created as part of an experiment but he never built a complete machine.
- Major-General Henry P. Babbage (son) completed the construction of a Mill in 1906.
 - It calculated and printed many different multiples of π to 29 decimal places as a proof of concept.
 - The mill now resides in the Science museum (London) along with some other early Babbage machines.

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Ada Augusta Countess Of Lovelace



- Considered by many as the first computer programmer.
- One of her parents was a trained mathematician while the other was a famous poet.
 - Mother (Anne Isabella “Annabella” Milbanke) : a dedicated scientist
 - Father (George Gordon Byron “Lord Byron”): a famous, brilliant poet “biggest celebrity of his time”¹, “among the greatest of English poets”², “mad bad and dangerous to know”¹
- A close friend of Babbage.
- While in Italy Babbage wrote a description of the inner workings of the Analytic Engine (Italian).
 - Lovelace demonstrated that she understood Babbage’s work:
 - Lovelace produced an English translation (added extensive explanations).

Image: www.computerhistorymuseum.org

¹ Dr. Hannah Fry (faculty member at the UCL Centre for Advanced Spatial Analysis)

² “The Nation’s Favourite Poet Result – TS Eliot is your winner!”. BBC. Retrieved 25 May 2019

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Ada Augusta Countess Of Lovelace (2)

- She also demonstrated the ability to leap beyond them in creative ways:
 - Abstract symbols = general instructions
 - Conceived of using the device for much more e.g. the program would compose (unique/new music
 - JT: this was in the 1800s and only recently ~2020s can generate A.I. produce creative works.

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Optional External Video:

- Ada Lovelace Biography, her contributions to computing and her relationship with Babbage.
 - Short video:
 - <https://www.youtube.com/watch?v=1kLsW0NLsO8>
 - Longer documentary video from the BBC:
 - <https://www.youtube.com/watch?v=QgUVrzKQgds>
 - A lighter presentation about her life and accomplishments.
 - Not necessarily as careful with the facts as the other two videos.
 - How they interpret Lovelace's intellectual and technical prowess vs. Babbage around 2:00 is a hoot (especially his reaction to her suggestions).
<https://www.youtube.com/watch?v=4kueyMlmxhY>

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Percy Ludgate (1883 – 1922)

- Designed (and may have constructed) his own version of an Analytic Engine (1908).
 - The unit was controlled by instructions on paper tape.
 - Control could also occur from instructions entered on a special keyboard.
 - It could store 192 variables that were 20 digits long..
- Like Babbage's machine it was entirely mechanical however the mechanism was powered by an electric motor.
- "Unfortunately all of Ludgate's drawings and manuscripts appear to have vanished forever."
(Williams: Scientific Proceedings of the Royal Dublin Society)



www.history-computer.com

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After This Section You Should Know

- How work on the Analytic Engine came out of some of the challenges experienced while developing the Difference Engine
- What was the purpose of the Analytic Engine and when was it designed
- The significance of the Analytic Engine
- Ada Lovelace's relationship with Babbage and significance of her work on the Analytic Engine
- Who was the other person who designed/developed a version of the Analytic Engine

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References

- “A history of computing technology” (2nd Edition) Williams, M.R.
- “'Lovelace & Babbage and the creation of the 1843 'notes'". *IEEE Annals of the History of Computing*. **25** (4): 16–26.

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