

## *Discovery of Previously Unknown Replicas of Historical Calculating Machines Manufactured by Roberto Guatelli*

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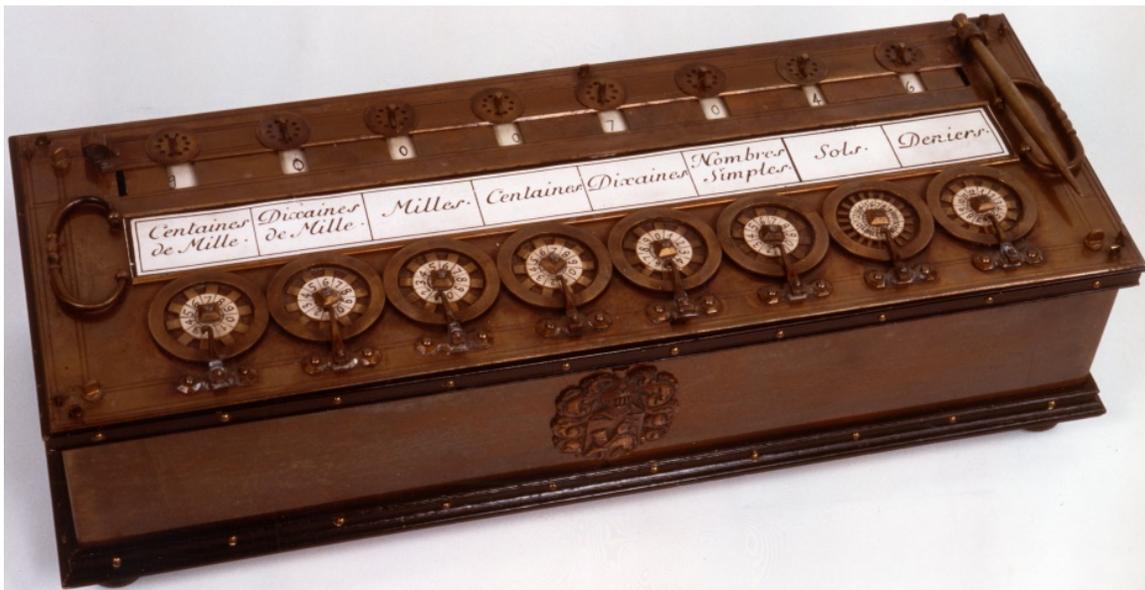
Leonardo da Vinci (1452–1519) produced a wealth of technical drawings (see Codex Atlanticus<sup>1</sup> or Codex Madrid<sup>2</sup>). For example, he already knew the gear train, the rack and pinion, the cam plate, the Nuremberg scissors, the sector, and the odometer and is said to have designed a mechanical calculator. The scholar and artist developed models for machines and instruments (e.g., loom and compasses), flying machines, ships, bridges, and churches for urban planning and military purposes (e.g., fortresses and knights controlled by cables). However, the interpretation of the sketches is not always easy.

Roberto A. Guatelli (1904–1993), an Italian engineer, was world-famous at the time but now forgotten. He spent a long time in a Japanese concentration camp during the Second World War. Apart from many Leonardo da Vinci models, he built the Pascaline, the four-function calculating machine of Gottfried Wilhelm Leibniz, the difference engine of Charles Babbage and Herman Hollerith's census machine. In 1968 Guatelli rebuilt Leonardo da Vinci's "calculating machine".

However, it is controversial whether this is actually a calculator. The excellent replicas are often confusingly similar to the originals.

### **Five previously unknown Guatelli replicas at Carnegie Mellon University, Pittsburgh**

It was not until December 2018 that it became known that Guatelli had also built a replica of the Millionaire direct multiplier made in Zurich. Other works of art were discovered in January 2019: calculators invented by Pascal, Leibniz, Pallweber and Webb. In 2018, eyewitness Pamela McCorduck donated the collection of calculating machines, including an early Thomas Arithmometer, a three-rotor and a four-rotor Enigma, to Carnegie Mellon University, Pittsburgh, PA. The Traub-McCorduck Collection is named in honor of her late husband, the computer science pioneer Joseph Traub. In 1988, the couple bought the five replicas from Guatelli. Guatelli replicas can also be found in Milan, Mountain View, New York, and Ottawa (see Figures 1-5).



**FIGURE 1. Reproduction of the Pascaline by Roberto Guatelli, Photo 1**  
The addition and subtraction machine built by Blaise Pascal (1623–1662) is able to process values up to 999 999 livres. 1 livre has 20 sols, 1 sol 12 deniers  
(© Museo nazionale della scienza e della tecnologia "Leonardo da Vinci", Milan).



**FIGURE 2. Reproduction of the Pascaline by Roberto Guatelli, Photo 2**

Eight original Blaise Pascal machines have been preserved. They are located in Paris, Clermont-Ferrand, Dresden, and New York. Pascal built the first machine in 1642. (© Canada Science and Technology Museum, Ottawa, object number 1979.0568.001).



**FIGURE 3. Reproduction of the Leibniz calculator by Roberto Guatelli**

Gottfried Wilhelm Leibniz (1646–1716) built his first calculating machine in 1673. The only surviving copy dates from the 1690s and is kept in Hanover, Germany. It is the world's first mechanical calculating machine capable of all four basic operations (© Museo nazionale della scienza e della tecnologia "Leonardo da Vinci", Milan).



**FIGURE 4. Reproduction of Babbage's Difference Engine by Roberto Guatelli**

In 1822, Charles Babbage (1792–1871) began developing his first difference engine, which remained unfinished. It was intended to produce error-free mathematical tables. The original machine is located in London (© Canada Science and Technology Museum, Ottawa, object number 2011.0022.001).

#### **How many da Vinci models and replicas of calculating machines have survived?**

As far as I know, there is no list of the models that Roberto Guatelli constructed based on Leonardo da Vinci's drawings. It is also unclear which and how many calculators he built for IBM New York and other clients and which survived where.

Guatelli was engaged from 1951 to 1961 for Thomas J. Watson Sr., the founder of IBM. The following year he opened a workshop in New York. According to Jim Strickland, Guatelli's nephew, Joseph Mirabella, began working with IBM in 1964. He continued the business after Guatelli's death until 2005. Mirabella had donated the Da Vinci models to the Long Island Science Center, Riverhead, New York. Nathan Myhrvold of Intellectual Ventures<sup>3</sup> (formerly of Microsoft corporation) is said to have acquired the remaining replicas of calculating

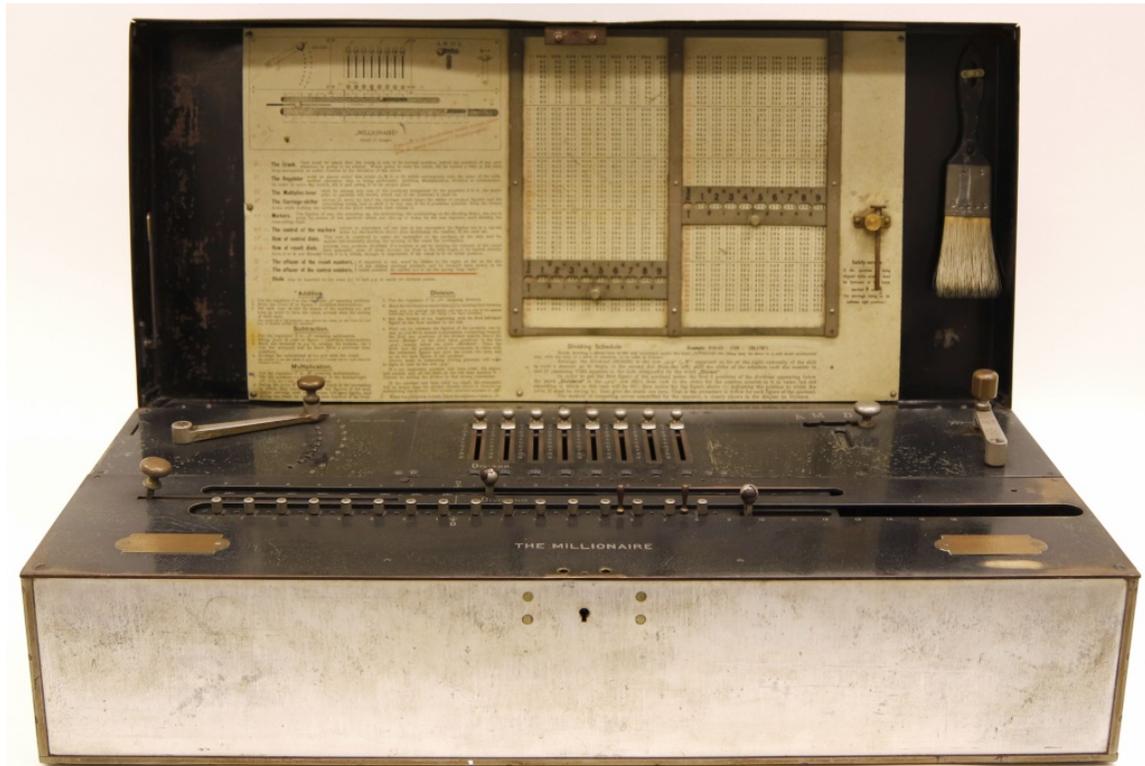
machines. Further information is still pending.

Heydenreich's book *Leonardo da Vinci*, to which Watson has written an epilogue, contains – apart from illustrations of the Mona Lisa and the Last Supper – numerous sketches of the universal genius, among them: anemometer, Archimedean screw and wheel, automatic drum, clock mechanism, coin stamper, diver's apparatus, dome, double hull for a ship, excavation machine, flying machine (ornithopter), helicopter, hydraulic pump, hydraulic screw, jack, lens grinder, machine gun, military port, military tank, odometer, parachute, printing press, projector, rotating bridge, screw cutting machine, self-propelled ship, spring-driven car, transmission (differential), two-level bridge, and ventilator.

### Millionaire direct multiplier

It is not known where the original Millionaire machine (factory number 2380), which Guatelli rebuilt, is located. It is missing in John Wolff's Australian "Register of Millionaire calculators". The Millionaire in the artifacts collection of the IBM Corporate Archives

in Poughkeepsie, New York, has the number 403. The four copies of Harvard University, Cambridge, MA, which worked with IBM, have different serial numbers. For many years, the Millionaire, mass-produced by H.W. Egli Ltd. in Zurich, was the world's fastest multiplication machine



**FIGURE 5. Replica of the Millionaire direct multiplier of Guatelli**

The numbers are entered with the setting levers. The values are transferred to the accumulator with the crank (top right). On the top left you see the multiplication lever, which very much accelerates multiplications (Picture credit: Heidi Wiren Bartlett, University Libraries, Carnegie-Mellon-University, Pittsburgh).

#### Guatelli replicas of calculating machines known so far

##### Museo nazionale della scienza e della tecnologia "Leonardo da Vinci", Milan, Italy

- Pascaline  
Replica. Several different originals (1642 and later) have survived (e.g., Paris, Clermont-Ferrand, Dresden).
- Gottfried Wilhelm Leibniz's calculator (c. 1694)  
The only preserved original is in the Gottfried Wilhelm Leibniz Library in Hannover.

#### Computer History Museum, Mountain View, CA

- Pascaline  
Replica (1981). Several different originals (1645) have been preserved (including Clermont-Ferrand, Paris, Dresden, New York).
- Difference engine no. 1 (demonstration piece) by Charles Babbage  
Replica (1972) of the original from 1833, which can be found in the Science Museum in London.
- Herman Hollerith's census machine (tabulator, sorter, card puncher)
- Herman Hollerith's electrical tabulating system

### Canada Science and Technology Museum, Ottawa

- Pascaline Replica (c. 1978). Several different originals (1642 and later) have been preserved (Clermont-Ferrand, Paris, Dresden, New York).
- Difference engine no. 1 (demonstration piece) by Charles Babbage, replica (1972) of the original from 1833, which can be found in the Science Museum in London.

### Carnegie Mellon University, Pittsburgh, PA (Traub-McCorduck Collection)

- Pascaline Replica. Several different originals (1642 and later) have survived (e.g., Paris, Clermont-Ferrand, Dresden).
- Gottfried Wilhelm Leibniz's calculator (c. 1694) The only preserved original is in the Gottfried Wilhelm Leibniz Library in Hannover.
- Charles Henry Webb's adding machine, New York Webb patented his machine in 1868. It was operated with a pen.
- Key-driven adding machine of the Adix Company, Mannheim, Germany The inventor of this single digit adder was Josef Pallweber, Mannheim (patent 1904). The portable ratchet machine was manufactured by Adolf Bordt, Mannheim.
- Millionaire. The first Millionaire of H.W. Egli Ltd., Zurich, was constructed in 1893. This machine with serial number 2380 was produced around 1916. The machine was invented by the Swiss engineer Otto Steiger.

### IBM Corporate Archives, Poughkeepsie, New York

In the IBM archives<sup>4</sup> you can find several Guatelli replicas, including the Pascaline. It is not known who is the author of the calculating machines of Leibniz, Leupold/Braun/Vayringe, Morland, the analytical and the difference engines of Charles Babbage, the difference engine 2 of Edvard and Pehr Scheutz. Unfortunately no information is available.

### Leonardo da Vinci models

There are some museums with Leonardo da Vinci models, e.g., in Vinci, Florence, Milan, and Château du Clos Lucé, Amboise (France). Handmade replicas by Roberto Guatelli and Joe Mirabella are exhibited at the Long Island Science Center<sup>5</sup>, in Riverhead, NY. According to Marta Montagnaro, in the Museo Leonardiano di Vinci, there is only one Guatelli model, the Carro automotore (self-propelled car), 1952.<sup>6,7</sup>

In the IBM Corporate Archives in Poughkeepsie, New York, there are the following Leonardo da Vinci models

made by Guatelli: mobile mechanical music drum, flying machine, helicopter, odometer, paddlewheel ship, scaling ladder.

### Milestones in Analog and Digital Computing

A detailed description of the Pascal, Leibniz, Babbage, Hollerith, Millionaire calculating machines can be found in the following work<sup>8</sup>, see Figure 6.

- Herbert Bruderer: Meilensteine der Rechentechnik. Band 1: Mechanische Rechenmaschinen, Rechenschieber, historische Automaten und wissenschaftliche Instrumente, 2., völlig neu bearbeitete und stark erweiterte Auflage, Walter de Gruyter GmbH, Berlin/Boston 2018, xxiv, 727 pages (a revised and expanded 3<sup>rd</sup> English edition will be published in June 2020)
- Herbert Bruderer: Meilensteine der Rechentechnik. Band 2: Erfindung des Computers, Elektronenrechner, Entwicklungen in Deutschland, England und der Schweiz, 2., völlig neu bearbeitete und stark erweiterte Auflage, Walter de Gruyter GmbH, Berlin/Boston 2018, xx, 829 pages (a revised and expanded 3<sup>rd</sup> English edition will be published in June 2020).



FIGURE 6. The Covers of Volume 1 (left) and Volume 2 (right) of the “Meilensteine der Rechentechnik”, by Herbert Bruderer

### Acknowledgements

Many thanks to all people involved: Vincenzo Iannone, Mary Catharine Johnsen, Peggy Aldrich Kidwell, Karen Martin, Pamela McCorduck, Marta Montagnaro, David Pantalony, Paola Redemagni, Andrew Rosenbloom, Ed Thelen, Keith Webster.

Note: This article originally appeared on the Communications of the ACM website.<sup>9</sup>

## Notes

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 Bruderer, Herbert, *Milestones in Analog and Digital Computing*, Springer Nature Switzerland AG, Cham, 3<sup>rd</sup> edition 2020, 2 volumes, 2000 pages, 715 illustrations, 151 tables,  
<https://www.springer.com/de/book/9783030409739>
9. <https://cacm.acm.org/blogs/blog-cacm/234005-more-replicas-of-historical-calculating-machines-found/fulltext>

## Additional Sources

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