From the Abacus To the iPhone

CMC³ South – Spring Conference 2017

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From the Abacus
To the iPhone

[Images of historical computing devices: Abacus, ENIAC, iPhone 1, HP-35]
Mechanical Calculators of the 17th Century

The Main Characters

Wilhelm Schickard

Blaise Pascal

Gottfried Wilhelm Leibniz
Mechanical Calculators of the 17th Century
The Calculating Clock

Wilhelm Schickard
1592 - 1635

Herrenburg
Mechanical Calculators of the 17th Century

The Calculating Clock

“What you have done in a logistical way, I have just tried to do by way of mechanics. I have constructed a machine consisting of eleven complete and six incomplete sprocket wheels, which can calculate. You would burst out laughing if you were present to see how it carries by itself from one column of tens to the next or borrows from them during subtraction.”

Wilhelm Schickard
Mechanical Calculators of the 17th Century
The Calculating Clock

Schickard’s drawings, 1624
Mechanical Calculators of the 17th Century
The Calculating Clock

Computer History Museum
Mountain View, California
Mechanical Calculators of the 17th Century
The Calculating Clock

Six digit, decimal adding machine

Multiplying Unit

Storage for Intermediate Results
Mechanical Calculators of the 17th Century
Napier’s Rods
Mechanical Calculators of the 17th Century
Napier’s Rods

Example: 423 X 6

423 X 6 = 2538
Mechanical Calculators of the 17th Century
The Calculating Clock

Back View

Sheet of Paper
With 10 Rods
Mechanical Calculators of the 17th Century
The Calculating Clock

Input Dials

Dials and Wheels

Gears
Mechanical Calculators of the 17th Century

Blaise Pascal
1623 - 1662
Mechanical Calculators of the 17th Century

Les Machine Arithmétiques de Blaise Pascal

"Pascaline"

"I submit to the public a small machine by my invention, by means of which you alone may, without any effort, perform all the operations of arithmetic, and may be relieved of the work which has often times fatigued your spirit."

Blaise Pascal
Mechanical Calculators of the 17th Century
The Pascaline
Mechanical Calculators of the 17th Century
The Pascaline

Musée Henri-Lecoq
Clermont-Ferrand, France
Mechanical Calculators of the 17th Century
The Pascaline

The Marguerite Périer
Mechanical Calculators of the 17th Century
The Pascaline

The Queen of Sweden
Mechanical Calculators of the 17th Century

The Pascaline
Mechanical Calculators of the 17th Century
The Pascaline

Input Dial
Output Drum
The Nines Complement Method

**Definition:**

The nines complement of any one digit decimal number $d$ is $9 - d$.

**Examples:**

- The nines complement of 3 is 6.
- The nines complement of 9 is 0.

**Notation:**

Let the nines complement of $A$ be denoted by $\text{ncp} (A)$. 
Mechanical Calculators of the 17th Century
The Nines Complement Method

**Definition:**

The nines complement of any one digit decimal number $d$ is $9 - d$.

For any $n$ digit decimal number $A$, we have:

$$\text{ncp}(A) = 10^n - 1 - A$$

So that: $\text{ncp}(538) = 10^3 - 1 - 538$

$$= 999 - 538$$

$$= 461$$
Mechanical Calculators of the 17th Century
The Nines Complement Method

Using: \( \text{ncp} (A) = 10^n - 1 - A \)

We have: \( \text{ncp} (A - B) = 10^n - 1 - (A - B) \)

\[ = 10^n - 1 - A + B \]

\[ = \text{ncp} (A) + B \]

Note: \( \text{ncp} (\text{ncp} (#)) = # \)

Thus: \( A - B = \text{ncp} (\text{ncp} (A) + B) \)
Mechanical Calculators of the 17th Century
The Nines Complement Method

Thus: \[ A - B = \text{ncp} \left( \text{ncp} (A) + B \right) \]

**Example:** \[ 538 - 64 \]

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**Standard Method**

\[
\begin{array}{c}
538 \\
- 64 \\
\hline
474
\end{array}
\]

**9’s Complement Method**

\[
\begin{array}{c}
\text{ncp} \\
\text{ncp}
\end{array}
\]

\[
\begin{array}{c}
461 \\
+ 64 \\
\hline
525
\end{array}
\]
Mechanical Calculators of the 17th Century
The Pascaline

The Scientific Machines
Mechanical Calculators of the 17th Century

The Pascaline

The Chancelier Séguier

The Accounting Machines

<table>
<thead>
<tr>
<th>all other dials</th>
<th>fourth dial</th>
<th>third dial</th>
<th>second dial</th>
<th>first dial</th>
</tr>
</thead>
<tbody>
<tr>
<td>base 10</td>
<td>base 10</td>
<td>base 10</td>
<td>base 20</td>
<td>base 12</td>
</tr>
<tr>
<td>Hundreds ...</td>
<td>Tens</td>
<td>Livres</td>
<td>Sols</td>
<td>Deniers</td>
</tr>
</tbody>
</table>
# Mechanical Calculators of the 17th Century

## The Pascaline

### The Léon Parcé Collection

### The Surveying Machines

<table>
<thead>
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<th>fourth dial</th>
<th>third dial</th>
<th>second dial</th>
<th>first dial</th>
</tr>
</thead>
<tbody>
<tr>
<td>base 10 Tens</td>
<td>base 10 Toises</td>
<td>base 6 Pieds</td>
<td>base 12 Pouce</td>
<td>base 12 Lignes</td>
</tr>
</tbody>
</table>
Mechanical Calculators of the 17th Century
The Pascaline

Musée des Arts et Métiers
Paris

Musée Henri-Lecoq
Clermont-Ferrand

Musée Roger Quillot
Clermont-Ferrand
Mechanical Calculators of the 17th Century

Gottfried Wilhelm Leibniz

The Derivative: \( \frac{dy}{dx} \)

The Integral: \( \int f(x) \, dx \)
Several years ago I saw for the first time an instrument which, when carried, automatically records the number of steps taken by a pedestrian. It occurred to me at once that the entire arithmetic could be subjected to a similar kind of machinery so that not only counting but also addition and subtraction, multiplication and division could be accomplished by a suitably arranged machine easily, promptly, and with sure results.

Gottfried Wilhelm Leibniz
Mechanical Calculators of the 17th Century

Gottfried Wilhelm Leibniz Library
Hanover, Germany
Mechanical Calculators of the 17th Century
Hanover
Mechanical Calculators of the 17th Century
Mechanical Calculators of the 17th Century
Mechanical Calculators of the 17th Century
The Stepped Reckoner
Mechanical Calculators of the 17th Century
The Stepped Reckoner

Staffelwalze  –  Stepped drum
Mechanical Calculators of the 17th Century
The Stepped Reckoner

Output wheel
Input dial
Rotating rod
Stepped drum
Mechanical Calculators of the 17th Century
The Stepped Reckoner
Mechanical Calculators of the 17th Century
The Odyssey of the “Younger Machine”

1690 – 1716: Under construction
1716 – 1764: Stored in Hanover
1764 – 1879: Stored in Göttingen
1879 – 1894: Returned to Hanover
1894 – 1896: Restored
1896 – present: Gottfried Wilhelm Leibniz Library
Mechanical Calculators of the Seventeenth Century