Lecture 4.
The World of Calculators: from office equipment to pocket gadgets

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Introduction

In the 17th, 18th, and the first half of the 19th century the dominating and prevailing calculating aids were:

- pen-and-paper methods (algorithms);
- abacus (in its variety of forms);
- mathematical tables.

To fully recognize the significance of these calculating methods and aids, one needs only to mention that the pen-and-paper methods are taught at schools for this day, that the abacus is frequently used to teach numbers and counting to pre-school children, and that printed tables with data are still in use in a number of areas.

It would be the historical role of the digital electronic calculators and, in particular the hand-held (or pocket) calculators to relegate most of the mathematical tables and abacus-like devices to historical relics of computing housed in museums and private collections.

The birth of the office calculator industry

The industrial revolution brought new manufacturing methods and with them the ability to produce good quality precision instruments and mechanical devices, such as calculators, in large quantities. In the first half of the 19th century, an increasing number of calculators were offered commercially but their use was not widely spread.

It all changed in the second half of the 19th century, first in Europe and, later, in America when large businesses, agencies, and institutions, such as treasuries or banks, were expanding fast, putting more and more people into their offices. It became evident that ever increasing number of calculation tasks could not be handled cost-effectively without appropriate calculating aids.

While institutions were looking for efficient ways for conducting their business, inventors and entrepreneurs were determined to supply them with all sorts of office gadgets. In the second half of the 19th century, mechanical office equipment became an essential infrastructure of a modern business. The first typewriters appeared in the early 19th century and the first wave of useful calculators soon after in Europe and a few decades later in America.

By the end of the 19th century, calculators would not be viewed as mechanical curiosities any more but as useful devices enhancing human abilities in a vast range of applications.

Thomas Arithmometer

Among the first commercially produced adding machines was the Arithmometer built by Thomas de Colmar of Alsace around 1820. Thomas Arithmometres were never produced in large quantities (some sources estimate that in the first 50 years no more than 1500 were manufactured). They were expensive and too slow for performing a large number of arithmetic operations in an office as the calculators required setting numbers using all sorts of dials (depending on a model) and a hand crank. However, Thomas Arithmometres were technically sound, captured the attention of businesses, and started office calculator industry, first in Europe and, then in America.

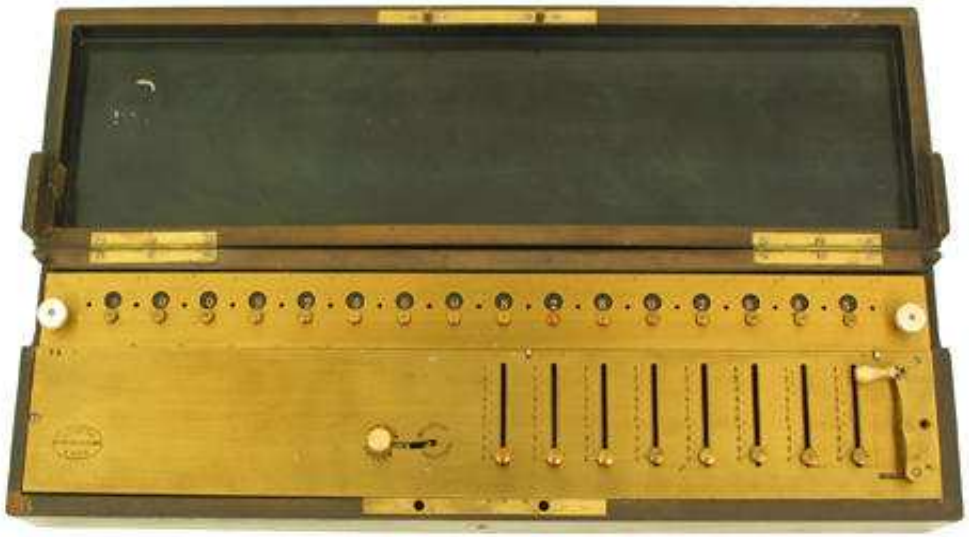

Fig. 1. An early Thomas Arithmometer. Source: http://archive.computerhistory.org.

Calculator industry in the 19th century America

America entered the age of mechanical calculators in late 19th century, much later than Europe. When major European countries were undergoing extensive industrialization at the time of the appearance of Thomas calculators, the United States was still primarily involved in agriculture while Canada was not even on the map as a country.

The Civil War of 1861–1865 did not help with the industrialization either, delaying the effects of the industrial revolution on the American landscape for a decade.

It was not until after the Civil War when new forms of manufacturing (steam-powered) allowed the American industry to grow and spread across the nation. It was at that time, when a vibrant office equipment industry was created with calculator manufacturing centers in cities such as Chicago, Detroit, St. Louis, and Philadelphia.

American companies and organizations seemed to like office gadgets from the start (typewriters, cash registers, calculators, telegraph, telephone) and that created a potential for mass manufacturing of such devices.

It was soon evident that, for an office calculator to be truly practical, some major improvements to calculator designs had to be introduced. There were two main issues:

- early mechanical calculators were slow to operate; the process of entering numbers and performing operations should be as fast as typing on a typewriter;
- some organizations, such as banks, required printed records of calculations and combining a calculator with some sort of a printing device would improve the efficiency of office work.

Who were the clients?

In the 19th and early 20th century America, there were, roughly speaking, three groups of calculator users which can be classified with respect to calculation and data processing needs. These groups were:

A. governmental institutions (such as treasury) and other large organizations (such as banks, large manufacturers),

B. medium-sized trade and commerce businesses (grocers and merchants);

C. small business and individual users (small business and home economics, and other purposes).

Institutions and organizations in group A required large machines capable of reliable operations with large numbers at high speed, and capable of printing the results of calculations on a wide roll of paper. Machines for this group of customers were undergoing continuous improvements. They were also very expensive.

The second group of customers, B, was also offered a range of advanced machines. They were still expensive (for an average individual), while printing, if available, was typically done on narrow paper tapes.

Finally, the last group of calculator users, the group C, was served by inexpensive small desktop, or hand-held type calculators. These rudimentary calculators were frequently working on the principles of an abacus and did not have carry mechanism implemented. Despite their simplicity, they survived until 1960s when they were offered as inexpensive pocket calculators operated with a stylus (we shall see examples of such calculators at the end of this lecture).

19th Century American Business Calculators

When discussing the impact of calculators on the modernization of an American office in the 19th and early 20th century, two individuals, in particular have to be mentioned: Dorr E. Felt and William S. Burroughs. Both were determined to provide businesses with just the right kind of calculators: fast in operations and with printing abilities. In the end, they created calculator empires that dominated the calculator market well into the next century.

Felt's Comptometer

Around 1886 Felt, a Chicago-based inventor and entrepreneur, invented a calculating device–the Comptometer–that, for the first time in the mechanical calculator history, featured a well-performing typewriter-like keys to enter numbers rather than inconvenient wheels, leavers, and alike (there were earlier attempts at designing key-operated adders in Europe and U.S.).

Fig. 2. One of Felt's comptometers. Source: unknown.

Since 1887, Felt&Tarrant Manufacturing, a company co-founded by Felt and Robert Tarrant (a Chicago machine shop owner), had manufactured a long line of business calculators that were sold all over the world. The company became very successful in the early 1900s and its dominating role in the world-wide business calculator market continued into the 1950s.

Felt&Tarrant success was based on novel sales and marketing techniques adopted by the company, such as free trials before purchasing, the collection and publishing testimonials of satisfied customers, and extensive and well-planed advertising campaigns (see Figures 3, 4, and 5).

Fig. 3. A 1892 comptometer ad with testimonials of satisfied customers. "*Martin D. Stevens & Co., Commission Merchants, Chicago, write: "The greatest assistant ever invented for bookkeeper."*

Mr. I.F. Elliott, Assistant Cashier Farmers' and Merchants' Bank, Humansville, Mo., writes: "I consider it the greatest labour saver for accountants ever put on market.""

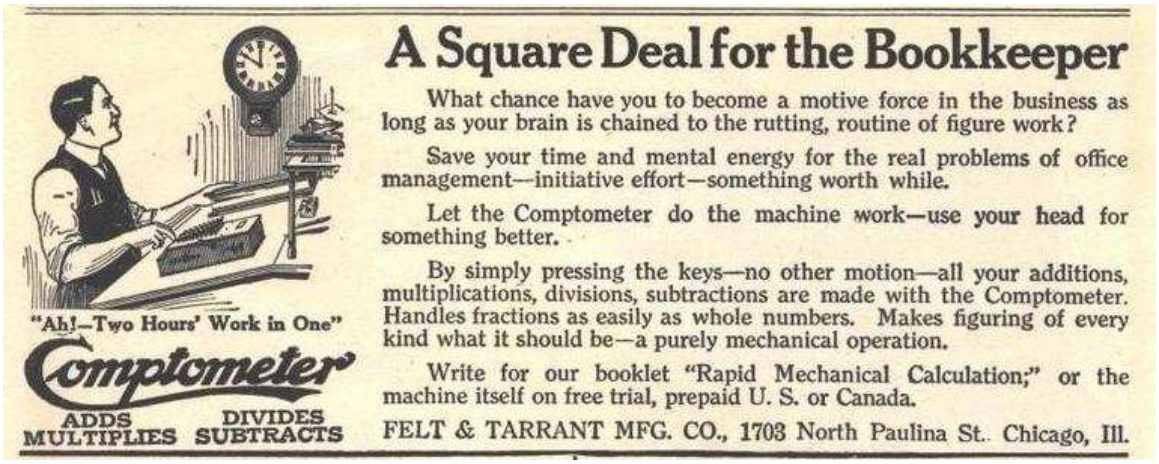

Fig. 4. A 1912 comptometer ad announcing free trials in U.S. and Canada. " *Write for our booklet "Rapid Mechanical Calculation," or the machine itself on free trial, prepaid U.S. or Canada.*" Source: unknown.

Greater speed of the Comptometer, without sacrifice of accuracy, is simply a matter of one operation as opposed to two. Ordinary machines require that keys be pressed, then lever pulled by hand or motor-operated. With the Comptometer, the entire operation of adding, subtracting, multiplying or dividing is completed by pressing the proper key or keys. Seconds saved by the elimination of the second operation quickly mount up to precious minutes, hours . . . and dollars.

COMPTOMETERS keep Eastman Kodak Co. figures "in focus"

Every business is a picture in figures. Those figures should be as accurate and sharp-focused as an expert photographer's print. "Hazy" figures may well lead to "hazy" decisions—and "blurred" profits.

In the manufacturing plants and offices of the great Eastman Kodak Company, more than 100 Comptometers are used for handling such important figure work as production, costs and payroll, inventory control, general accounting and statistical work.

Tribute to Comptometer methods is the fact that Eastman Kodak Company has used Comptometers since 1908, found them accurate, efficient, and flexible enough to meet rapidly changing business conditions over three turbulent decades.

THE MODEL J COMPTOMETER

No thinking person can "laugh off" the fact that so many progressive businesses (small concerns as well as industrial giants) have adopted Comptometer methods of handling vital figure work. For a demonstration in your own office, on your own job (without obligation, of course), telephone your local Comptometer representative, or write direct to Felt & Tarrant Mfg. Co., 1752 North Paulina Street, Chicago, Illinois.

COMPTOMETER

Reg. U. S. Pat. Off.

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Fig. 5. A client (Kodak) testimonial converted into a 1938 comptometer ad. Source: unknown.

Fig. 6. A "comptometer room" at Cannon Mills Inc., c. 1940s. Source: unknown.

Comptometers were not just calculators; their popularity created an office category for these devices. There were typewriters and phones, there were office calculators, and there were the comptometers.

In one of the 1940s comptometer ads, E.G. Bost, Treasurer of Cannon Mills Inc. an American textile company employing some 18,000 people, said:

> To keep our figure work up to the minute and under control at all times, we have become more and more dependent on Comptometers. ... Comptometers are producing efficient results in our Payroll, Accounting, Billing, Account Payable, Cotton, and other departments. They have effected interesting and valuable short-cuts and give us figures we can count on. [from a 1940s comptometer ad, see Figure 5]

Comptometers were useful but expensive. For companies which could not afford advanced office calculators such as comptometers, there was an option of renting equipment or using services of companies dedicated to providing calculation services.

Fig. 7. A comptometer ad from *Time*, December 28, 1942.

One had to learn how to use a comptometer skillfully but once the use of the machine was mastered, a person became a "comptometer operator" and could start claiming up the office ladder.

The company sponsored schools for machine operators, first in Chicago, then across America and Europe.

Fig. 8. According to http://www.vintagecalculators.com/html/comptometer.html, this photograph appeared in the January 1955 issue of the "Office Magazine" with the caption "Over 180 girls a year pass through the Liverpool school for Comptometer operators run by Felt&Tarrant Ltd."

In 1888, Felt improved his Comptometer by adding a printing device and named the machine Comptograph. Felt & Tarrant Manufacturing changed its name to Comptometer Corporation in 1957, and was acquired in a merger by Victor Adding Machine Company in 1961.

The Tail of Burroughs

Another American calculator inventor of note was William S. Burroughs. Working as a bank clerk he envisioned the process of tedious arithmetic operations mechanized to such a degree that the results would also be printed on paper.

In the end, Burroughs not only designed such a machine–the Arithmometer (1884)–but also co-founded American Arithmometer Company in St. Louis to manufacture the machine. His first Arithmometer was just a nine-digit adding machine with a printing mechanism designed to record only the final result of calculation. However, it was the first calculator with working printing mechanism.

Fig. 9. One of the early Burroughs' Arithmometers. Source: unknown.

By the end of the 1800s, the company was successfully selling several hundred machines a year.

The real success came at the beginning of the 20th century, unfortunately, after Burrough's death. The Arithmometer was awarded gold medal at the Paris 1900 Exposition, gaining international attention.

The company was growing very fast, moved to Detroit in 1904 and, a year later, was renamed as Burroughs Adding Machine Co.

Some historians estimate that by 1910, there were approximately 100,000 Arithmometer users.

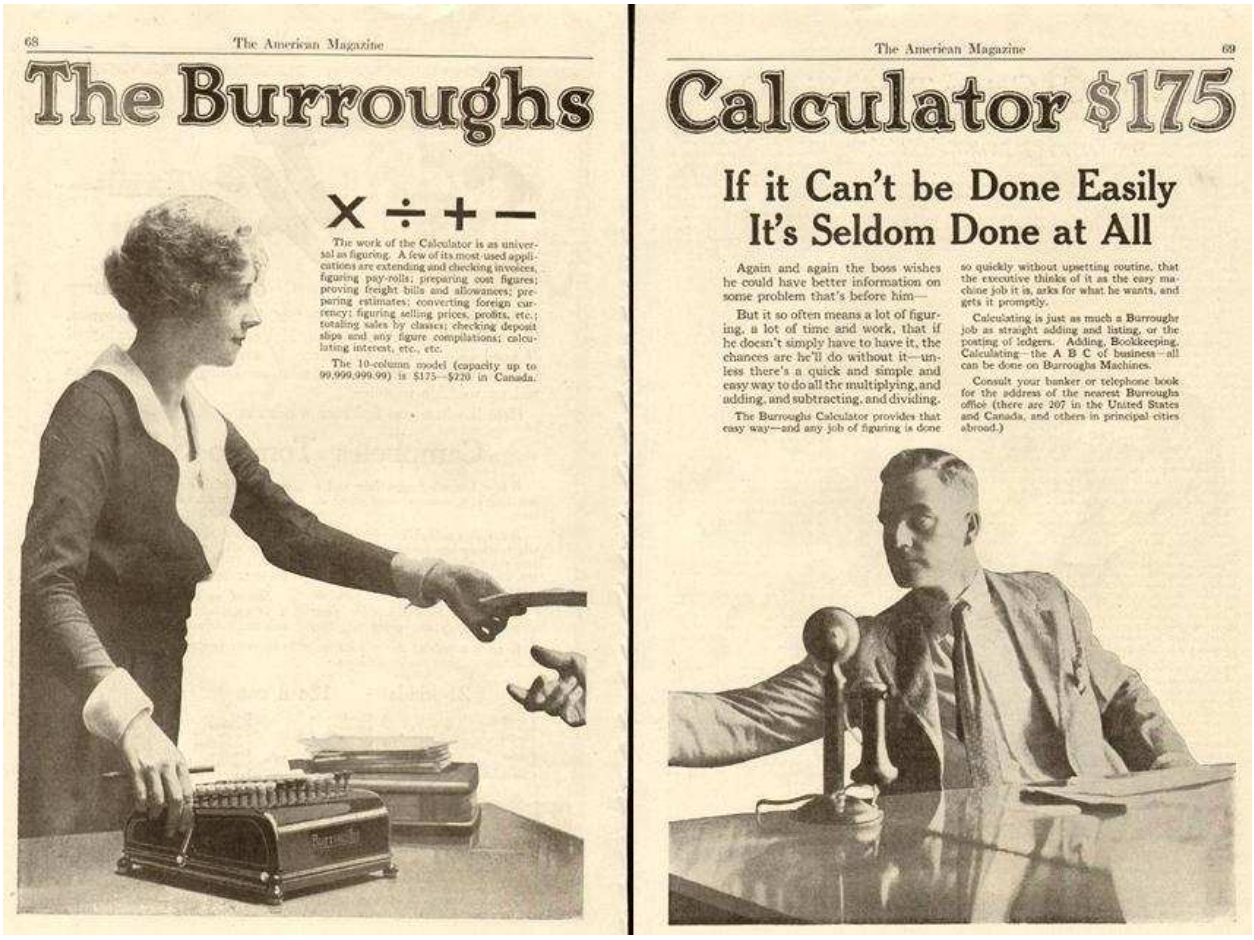


Fig. 10. A 1919 Burroughs calculator ads. The calculator resembles very closely a Felt & Tarrant comptometer. Note that by the early 1920's, the price of the Ford Model T car was about $300.

Small and medium-sized business that could not afford their own extensive calculator departments could, instead, use services of companies created for the very purpose of delivering efficient calculation services. In the 1940s, one of such companies was Workman Service – a provider of calculating services to clients in Chicago, New York, Minneapolis, Seattle, and Los Angeles.

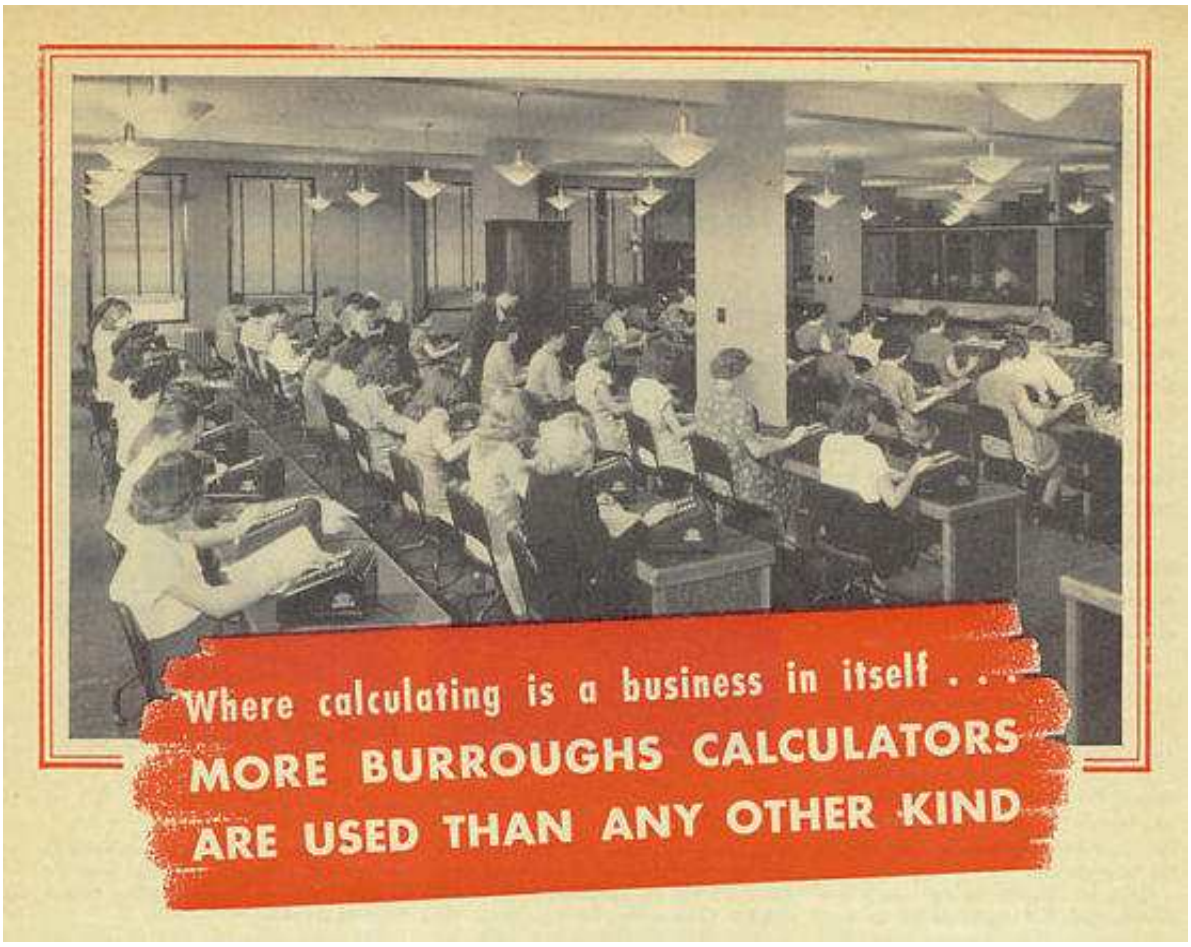


Fig. 11. A 1948 Burroughs calculator room of Workman Service.

In the last century, Burroughs was not only one of the best known calculator manufacturers but one of the very few of such companies that were able to take advantage of the rapid advancements in electronics industry.

In the early 1950s Burroughs introduced a new generation of electric, office accounting machines–Sensimatic–which was able to perform many business functions semi-automatically. Its refinements could even store the results of calculations on a magnetic stripe.

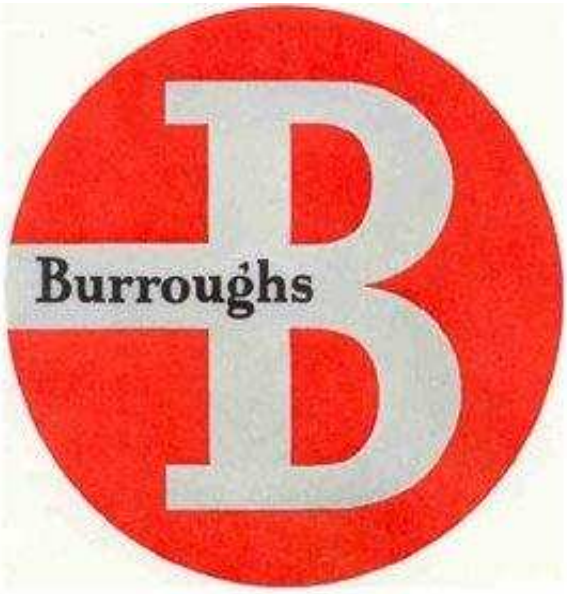


Fig. 12. Burroughs 1947 company logo.

Fig. 13. "Her own Sensimatic!", a 1954 add of Burroughs Sensimatic.

Fig. 14. A 1954 add of Burroughs Sensimatic.

Burroughs Adding Machine Company was renamed the Burroughs Corporation and began moving into computer products in the late 1950s.

In the 1960s and 70s, Burroughs was one of the major American computer companies. The move into the computer sector was an indication of what was awaiting the business caclutaor market – the merger with business computer equipment from the so-called key edit systems, to programmable word processors and desktop business computers.

Fig. 15. Burroughs L8000 business computer system, 1972.

After a century in existence, Burroughs merged with Sperry Corporation to form Unisys in 1986.

Calculators for the rest of us

In the 19th century, not only businesses but also individuals (office workers, small merchants and grocers, ordinary tax payers) sought assistance with every-day-arithmetic from calculating aids, such as calculators. However, Comptometers, Arithmometers, and other business calculators were too expensive for an average individual (to buy or to rent) and that created business opportunities for others.

As a result, small, inexpensive, mechanical calculating machines quickly began to penetrate the market offering reliable means of performing every-day arithmetic to everyone.

Marketing of these calculators required a language of purpose and benefits understood by every businessman. By the end of the 19th century, such language spoke of the calculators operational power, simplicity of use, affordability, and private, individual ownership. In 1893, The Ribbon Adder of New York was advertising its new calculating machine as one that

> does all that can be done by arithmetic - multiplying, adding, and subtracting sterling currency as well as decimal, and fractions. Simple as a tape measure, its workings are understood at a glance... And while the prices of calculating machines hitherto have been almost prohibitive, the Ribbon Adder is furnished at a price which brings it within the means of all.

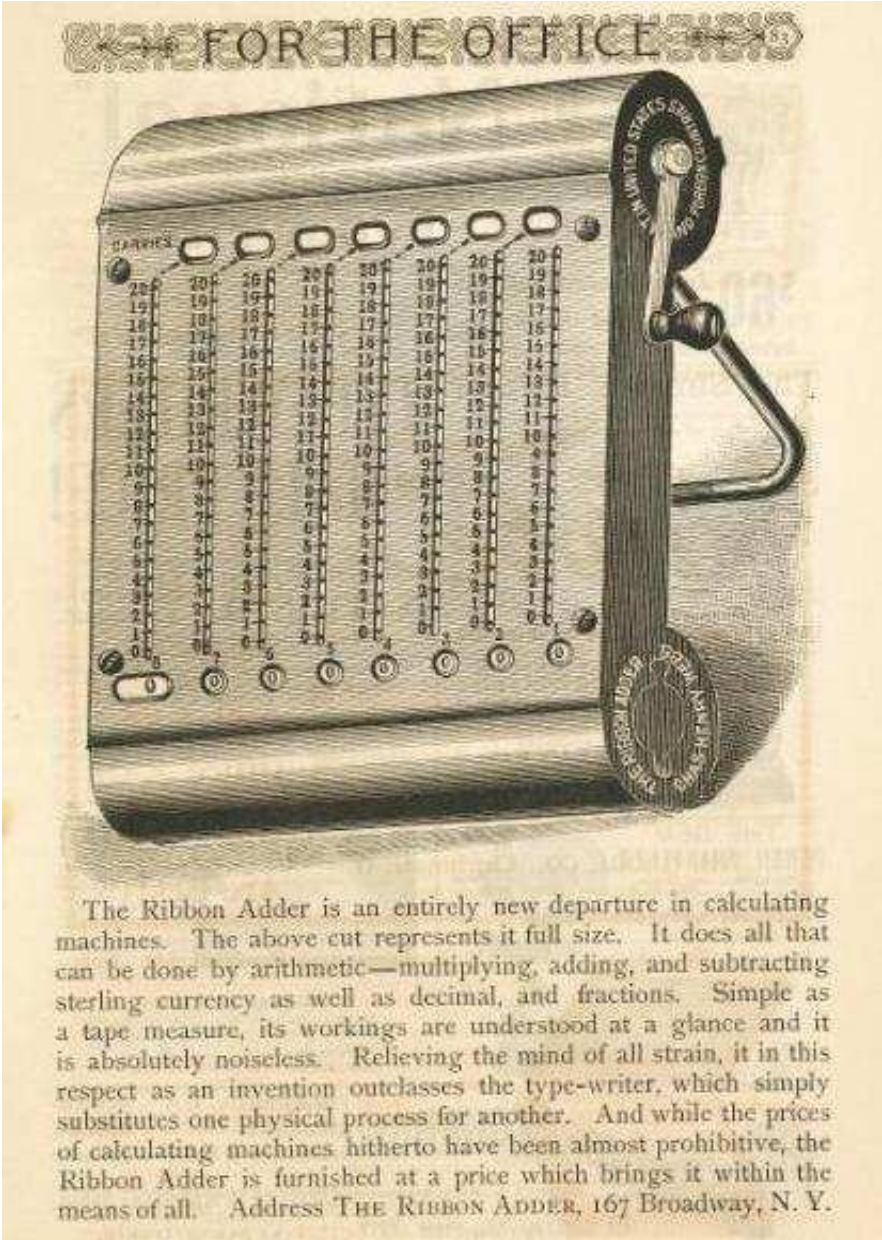


Fig. 16. A 1893 ad of Ribbon Adder manufactured by Ribbon Adder of New York.

Early American "personal" calculators

Early "personal" calculators were inexpensive but of rudimentary design. Some of them could not perform the carry operation automatically. The designs of some of these gadgets, such as that of the Locke adder (see Figure 18), was similar to the "stick calculator" discussed in the previous lecture.

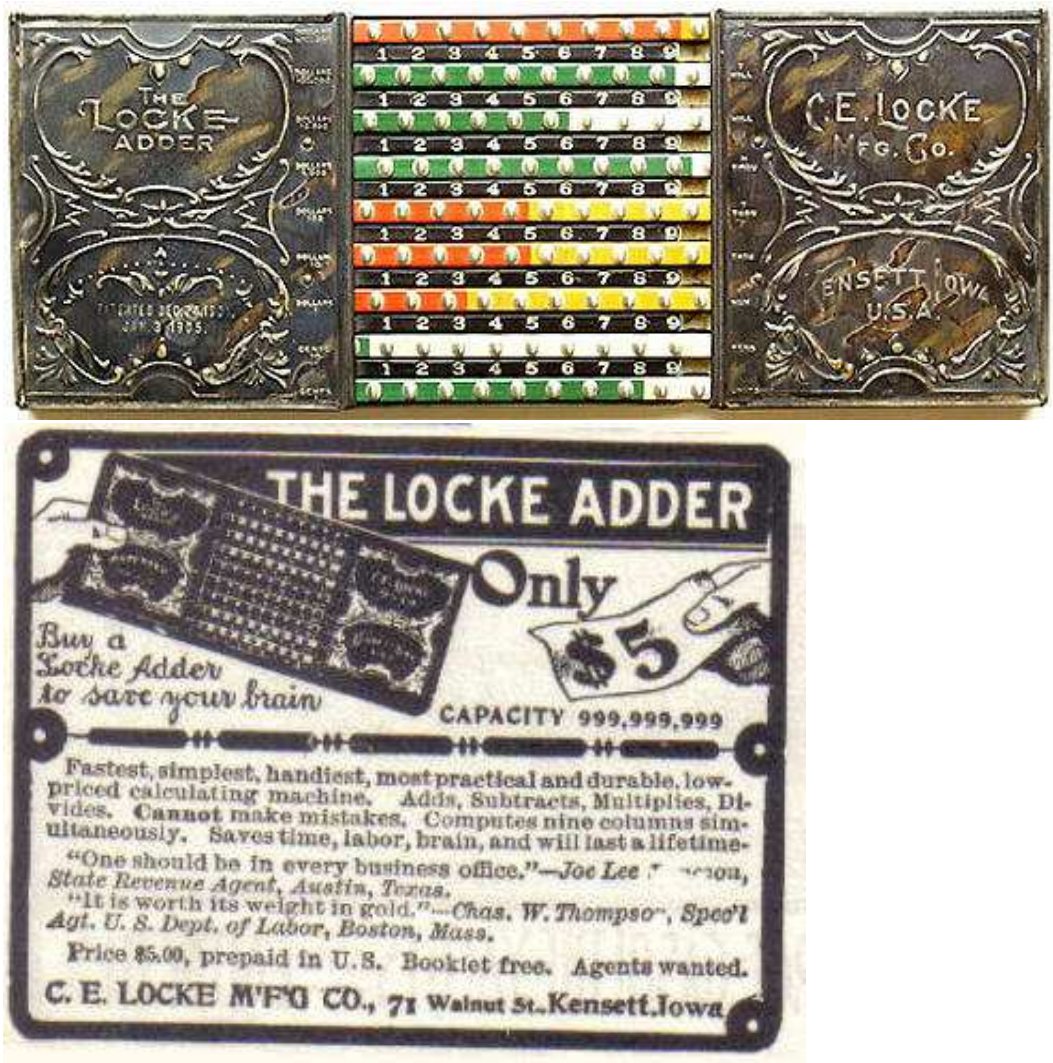


Fig. 18. Lockey adder (top) and and one of its 1902 ads with customer testimonials: "*One should be in every business office... It is worth its weight in gold.*"

Other designs, such as that of the Lightning Portable Adding Machine (see Figure 19) still used dial wheels with numbers, as in Pascal's devices.

Fig. 19. The Lightning Portable Adding Machine introduced by Lighting Adding Machine Co., Los Angeles in 1908. Source: York University Computer Museum.

The Locke adder was unsophisticated but popular in the early 20th century. Stylus operated adding machines, such as the Lightning Portable Adding Machine, were selling very well for decades.

The down of "personal" calculators

Mechanical calculators acquired the adjectives 'portable', 'personal', 'pocket', and 'home' in the early 20th century. Lighting Adding Machine Co. advertised its machines as *portable*. Other companies went even further.

In 1904, Automatic Adding Machine Manufacturing of New York began advertising its small GEM calculator as Your Personal Adding Machine; For Desk, Pocket, Home (see Figure 20).

Fig. 22. Automatic Adding Machine Manufacturing's GEM calculator, Source: unknown.

Since then, the names of calculators have been frequently prefixed with the word personal. Small mechanical slide adder Valiant Personal Calculator (see Figure 21) can serve as an example. It was sold in 1962 for 77 cents. A large variety of such pocket, personal slide calculators (no automated carry!) were sold and used until 1970s.

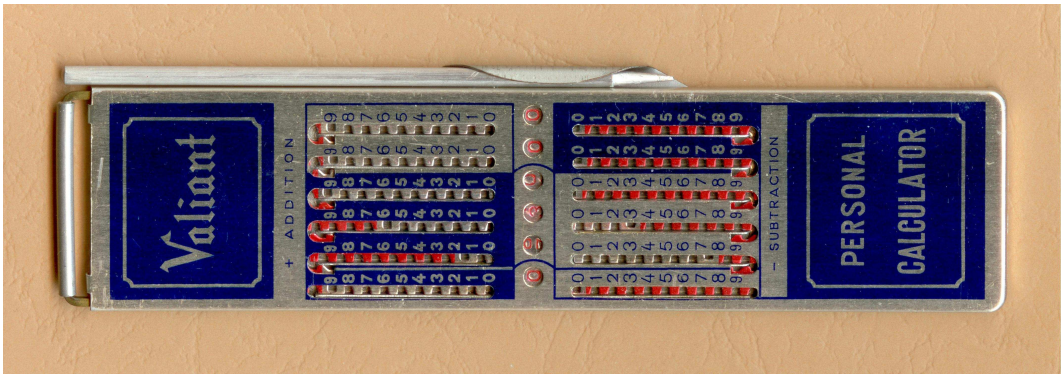


Fig. 20. Valiant Personal Calculator manufactured in the 1960s(?). Source: York University Computer Museum.

The invention of a transistor and, later, of an integrated circuit allowed to replace mechanical, electro-mechanical, and early electronic calculators with sophisticated scientific programmable and business calculators in the 1960s.

The first digital programmable electronic desktop calculator–the Mathatron–was offered in 1963 by Mathronix. The company advertised it as an inexpensive computer: "*Vanquish your problems as they come, with Mathatron, the $5,000 digital computer.*" The phrase "Vanquish your problem", instead of statement such as "Vanish your company's problems", indicates that the calculator was aimed at individual use although in 1963, $5,000 could by two brand new Ford Mustangs (retailed in 1964 for $2,495).

Fig. 20. Mathatron – the first digital programmable electronic desktop calculator offered by Mathronix in 1963. Source: York University Computer Museum.

The majority of individuals had to wait for the arrival of affordable electronic calculators for another decade and for another major advancement in micro-electronics, especially in integrated circuit technologies.

But when the hand-held (or pocket) calculators arrived in 1971, first from Bowmar Instrument and, soon after from scores of other calculator manufacturers (including Canadian firms Commodore and Rapid Data), the consumer electronics market entered one of the hottest periods in its history.

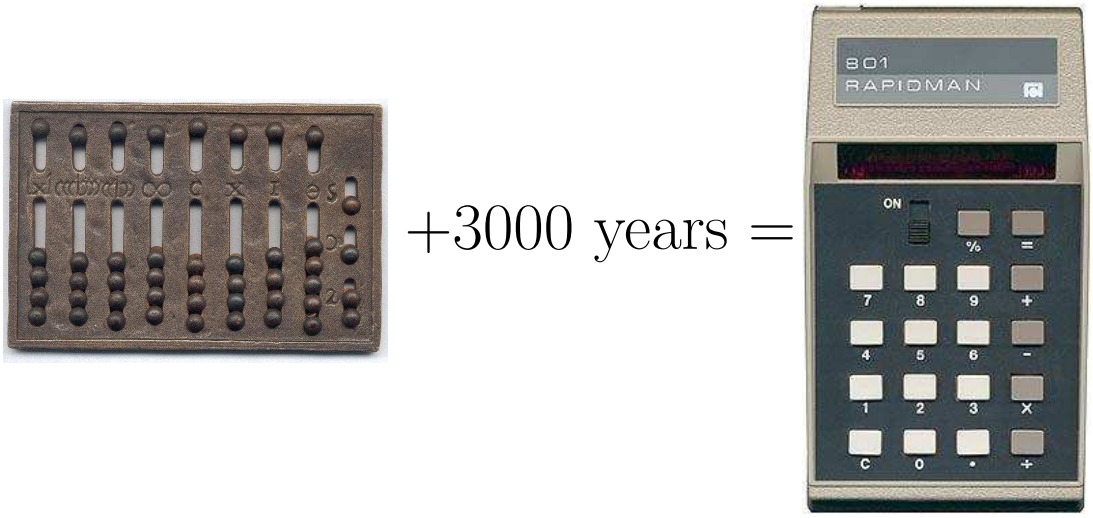
Fig. 20. This Rapidman 800 Calculator was introduced by Toronto-based Rapid Data in 1972. Source: unknown.

The promise of a calculator power at your finger tips was rapidly gaining social acceptance.

It wasn't so much the 'cigarette pack' size or the aesthetically pleasing plastic cases that attracted people to these new gadgets. It was the idea of a personal calculator, of a powerful, inexpensive calculating device for your own unrestricted use, always in your pocket, in your briefcase, or on your desk. The idea first expressed with the Roman hand-held counting board more than two thousand years ago, had finally found its way to fully realize itself with the advent of a sophisticated semiconductor device – the microprocessor.

Conclusions

In the late 19th century calculator industry branched into business and personal calculator paths. While the business calculator industry eventually merged with computer industry in the 1970s, the personal calculator industry remains a significant component of consumer electronics industry for this day.



In 5,000 years or so, we have build and modified calculating tools to help us coexist with numbers. From lines and pebbles of a dirt abacus, to the first mechanical calculators and, finally, to our present day microprocessor-powered personal calculators, the calculating gadgets have penetrated vast regions of our lives.

Today, we are as dependent on calculators as on computers, we use them and will continue to use them in a variety of forms. This is why every computer operating environment has a calculator and each smart phone has a calculator app.

References

- G.C. Chase, History of Mechanical Computing Machinery. *IEEE Annals of the History of Computing*, Volume 2, No. 3, July 1980.

- P. Aldrich Kidwell, 'Yours for Improvement' – The Adding Machines of Chicago, 1884-1930. *IEEE Annals of the History of Computing*, July-September 2001, pp. 3-21.

- E. Swartzlander, Generations of Calculators. *IEEE Annals of the History of Computing*, Vol. 17, No. 3, 1995, pp. 75-77.

- Williams, Michael, *A History of Computing Technology*, 2nd ed.