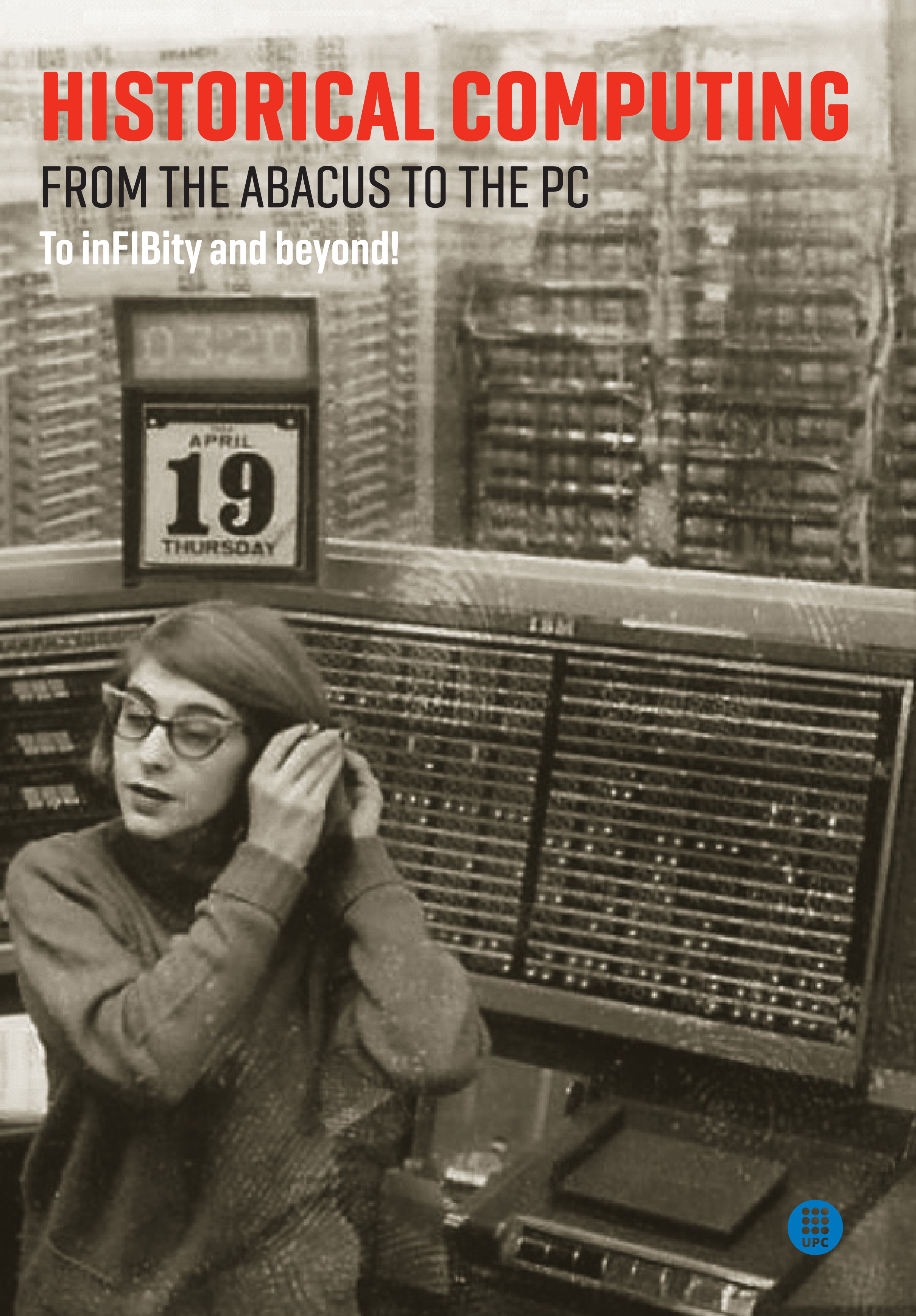
HISTORICAL COMPUTING

FROM THE ABACUS TO THE PC

To inFIBity and beyond!



UPC

HISTORICAL COMPUTING

FROM THE ABACUS TO THE PC

To inFIBity and beyond!

UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

ORGANIZED BY

WITH DE SUPPORT OF

COLLABORATED

Cover photographs: Margaret Hamilton, SAGE Project, 1962.
Margaret Hamilton, ICSE, 2018

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SALUTATION BY THE DEAN OF THE FIB

As the dean of the Barcelona School of Informatics (FIB) of the Universitat Politècnica de Catalunya (UPC), I am very honored to write you these greeting words on the occasion of the important events organized to conclude the celebration of our 40th anniversary. A celebration that has spanned over two academic courses, co-organized with the prior dean Núria Castell. You may view the complete program of activities for our 40th anniversary by clicking on: http://www.fib.upc.edu/ca/40e

From the very inception of this 40th anniversary, when initial proposals aroused, one such idea appeared that looked rather difficult to accomplish at that time, but for whom the effort was worth trying: Presenting our highest honor, that of Doctor Honoris Causa of UPC, to Ms. Margaret H. Hamilton, one of those female "hidden figures" that society and even our computing disciplines have re-discovered not so long ago.

Thanks to the work of many at FIB and UPC, and to the support of other schools and departments, a proposal was formally submitted and approved by UPC. On behalf of FIB and UPC, I want to sincerely thank Ms. Hamilton for accepting, and all those involved in the preparations for their efforts and support.

To make it bigger, a consequence of Ms. Hamilton's attraction power as a historical character, two additional events were proposed to FIB and have been organized for October 18th and 19th, both of them starting with Ms. Hamilton's awarding ceremony: The 1st Barcelona Grad Cohort Workshop (BGCW), with 50+ girls studying computing meeting with senior professional women, from industry and academia; and the general assembly of the spanish Conference of Deans and Directors of Informatics Engineering (CODDII), which will gather 60+ colleagues from all spanish universities providing higher computing programs. I want to welcome you all to FIB and UPC, and wish you a very fine and profitable stay among us.

To conclude, let me recall the many and diverse activities marking our 40th anniversary. We have learned about our origins as FIB, and publicly celebrated the creation of the first facultades of informatics in Spain with CODDII. We have honored those pioneers that preceded us, and remembered those beloved colleagues that recently past away. We looked at the past, present and future of some of our computing technologies. We partied at FIB, with our students, with FIB Alumni and with our local industry. Among those activities, a quite visible one has been the exhibition Computation: From the Abacus to the PC, held both outside and within UPC. Let me present you this special edition of its catalog, in English, as a warm gift for Ms. Margaret Hamilton and for the rest of you to remember FIB and UPC, and the happy events that have gathered us together.

JOSEP FERNÁNDEZ RUZAFA
Dean of the Barcelona School of Informatics,
Universitat Politècnica de Catalunya

Barcelona, October 2018

SALUTATION BY THE PRIOR DEAN OF THE FIB

The Barcelona School of Informatics (FIB) of the Universitat Politècnica de Catalunya (UPC) celebrates its 40th anniversary in 2017-2018. We've organised a series of activities that we wish to share with everyone, and particularly with the great community that surrounds our School and our university, students, professors, management staff, graduates and friends in general. The FIB had the pleasure of presenting one of these activities, the historical exhibition *Computation: From the Abacus to the PC*, which was held from 8 to 27 May 2017 in the Illa Diagonal shopping centre and from 29 May to 29 June at the UPC's Rector Gabriel Ferraté Library. With these locations, we seek to bring the FIB and the exhibition closer to both the general public and our community.

In addition to the university teaching and research that we carry out at the FIB, in recent years we have sought to share with Catalan society the advances and changes that are a staple of information technologies and our thoughts on a historical view of our discipline. To this end we've organised talks, round tables, several exhibitions and the FIB Museum, which has been visited by thousands of students over the last few years. The historical exhibition that we're now presenting builds on the content of past FIB exhibitions, but it focuses on examples of devices and objects that predate modern computer technology and that conditioned the design of the first computers.

This exhibition would not have been possible without the work of a large number of people and several institutions that have wished to contribute to its preparation. Previous versions of the exhibition were organised in conjunction with the University of La Rioja and the Open University of Catalonia, and we have been able to take advantage of much of the work carried out and the infrastructure needed. At the UPC, in addition to the FIB's staff, the Libraries, Publications and Archives Service, with the support of the Language and Terminology Service, and Iniciativa Digital Politècnica, have been particularly involved in the exhibition. We are sincerely grateful to all those involved.

To conclude, I wish to thank the exhibition's curator, our professor Joan Antoni Pastor Collado, for his work. He classified and documented the materials exhibited and combined pieces selected from the FIB Museum with his own and those of other collectors.

NÚRIA CASTELL ARIÑO
Prior Dean of the Barcelona School of Informatics,
Universitat Politècnica de Catalunya

Barcelona, October 2018

INTRODUCTION BY THE EXHIBITION CURATOR

Informatics, or computing, is one of the youngest academic and professional disciplines. If we count from the appearance of the first electronic computers, its history spans just eighty years. Compared to the centuries or millennia of experience accumulated in most sciences and fields of engineering, this history is very short, though certainly very intense.

In fact, since its inception, as well as being a young discipline, computing has developed in a way that reflects its youthful spirit. Its evolution has been characterised by constant invention, innovation and renewal in products, systems, methods, services and computing paradigms. Now we have social phenomena like smartphones, tablets, apps, the cloud, virtual reality, social media, online gaming and 3-D printing. And it was not so long ago that the emergent phenomena were the web, e-business and e-commerce, dot-coms, laptops, gaming consoles, and so on – advances that themselves succeeded the advent of the internet, PCs, arcade games, and other developments.

For decades, it's been common to hear people say things like "Computing is the profession of the future", or even "Computing is the future!" And our discipline has undeniably had a far-reaching and highly visible impact on contemporary life at every level. Our world is increasingly digital, global and automated thanks mainly to information and communication technology. We're moving ahead so fast and so far that it's not surprising we sometimes experience a kind of social vertigo when we contemplate the possible consequences of this progress.

We start to doubt the desirability and sustainability of automating certain processes, or feel uneasy, even fearful, about certain electronic monitoring and control practices that we now know some governments and multinationals engage in. As good computing professionals, we want to contribute to building a future that's more democratic, equitable and just. We also have a duty to fight against other, more dystopian futures – to ensure that our technologies are used for the common good rather than the benefit of a few powerful individuals.

In the middle of this short but fast-paced history, from time to time it's worth pausing to look back. Learning about and understanding the circumstances, vicissitudes and technologies that shaped the experience of our predecessors helps us take advantage of opportunities and avoid pitfalls as we build a better future for everyone. This is why in recent years, alone or in collaboration with other institutions, the Barcelona School of Informatics (FIB) has sought to celebrate the passing of time, our own time and history, and reflect on this journey.

We've done this by marking the anniversaries of some significant events, of which there have been quite a few lately. Some have been linked to individuals we recognise as visionaries in our field: the centenary of the birth of Alan Turing in 2012, the bicentenary of the birth of Ada Lovelace in 2015, and the septcentenary of the death of our patron, Ramon Llull, in 2016. To mark these occasions, we organised and participated in various talks and exhibitions, including a series of eight round tables in 2013-14 on topics related to the history of computing in Catalonia and Spain.

Particularly noteworthy for the engagement and visibility they generate are a series of exhibitions on retro computer technology, presented in Catalan shopping centres and town halls, and our collaborations with CosmoCaixa. Finally, having seen how curious people are about the history of computer technology, in 2010 we decided to establish the FIB Museum, which has attracted thousands of students, professors and other visitors since it opened.

In 2017-2018, the Barcelona School of Informatics is turning 40 and we wanted to celebrate this occasion too. We've organised a range of activities that we want to share with our students, professors, management staff, graduates, friends of the School, and anyone else who wants to join us. In addition to taking advantage of annual events such as the FIB party and Festibity (an ICT professional festival) to highlight the fact that we've now been "Creating Talent" for four decades, we've organised a film forum on "Computer Science and Science Fiction" and a series of talks on the "Present, Past and Future of..." various computer technologies, including programming languages, computer architectures, databases, and more.

We've also updated a special FIB website devoted to a select group of pioneering women who made a significant contribution to the advancement of computing and telecommunications. The site now includes two new entries, for Barbara Liskov, awarded an honorary doctoral degree by the UPC in 2012 at the proposal of the FIB, and for Margaret Hamilton, to whom we pay the same tribute in these dates. The full programme of activities to mark the 40th anniversary of the FIB can be viewed by clicking on the link below: http://www.fib.upc.edu/ca/40e

We love exhibitions, and the special events we organised include one entitled Computation: From the Abacus to the PC. The show, which is the focus of this catalogue and web space, was presented at the Illa Diagonal shopping centre in May 2017 and at the Rector Gabriel Ferraté Library in June 2017. This historical exhibition seeks to build on and complement the content of previous FIB exhibitions. It revolves around technologies, devices and objects that predate modern computer technology, but that conditioned the design of the first computers. In many cases, these older technologies were in use for much longer periods than the 80-year period in which "modern" computer technology has been around, and were ultimately absorbed into more recent developments. In addition to these precursor technologies, which show how people counted, added up, calculated, did accounting, and so on until just a few decades ago, we've included some objects related to the first giant computers, sometimes described as "electronic brains", and the earliest PCs, which popularised computer technology.

Many people from various institutions have offered their assistance and contributed to preparing this show. As the curator of the exhibition, I'd like to sincerely thank them for all they've done: at the UPC, my colleagues at the FIB, inLabFIB, the Libraries, Publications and Archives Service, Iniciativa Digital Politècnica, and the Language and Terminology Service; and outside the UPC, colleagues and friends at the University of La Rioja and the Open University of Catalonia (UOC), who worked on earlier versions of the show. There are so many of you, and you've all been so generous with your support. So you certainly deserve to be named in the lengthy acknowledgements section that accompanies this exhibition. Thank you very much for your contributions!

JOAN ANTONI PASTOR COLLADO
Barcelona School of Informatics, UPC
Vicedean for Institucional and International Relations

Barcelona, October 2018

Thank you, FIB!

The UPC libraries are privileged services thanks to the Barcelona School of Informatics (FIB), which is now celebrating its fortieth anniversary. Why is this so?

The UPC libraries, like those of other technical universities in Spain and Europe, do not have large collections of books. This is because, unlike in other fields, the support that libraries provide to education in technology is not mainly based on books. Instead, it follows an innovative learning model based on particular types of documents, such as reports, standards, plans, formulas, problems, solutions and studies. They also offer services related to technology, especially information and communications technology (ICT).

Thanks to ICT, the UPC libraries have pioneered dozens of innovative library projects. They were the first Spanish libraries to have automated bibliographic catalogues; they created and designed CD-ROM towers for consulting scientific and technical databases; they were pioneers in implementing integral library information management systems (with the VTLS product by Virginia Tech); and they founded the Consortium of Catalan University Libraries in order to create a single automated collective catalogue of the bibliographic records of all libraries in the Catalan university system. When the internet appeared, they were the first to publish digital books and were pioneers in offering open access to scientific and technical documents for researchers and professors through online repositories/servers such as UPCommons, now widely considered one of the world's best repositories of its kind. They also led the change from print journals to digital journals for consulting scientific information. More recently, they earned the admiration of other universities with the Futur research portal, and have just put into operation the GeoCommons project of geo-location of the theses and projects of our students, professors and researchers, allowing anyone to locate them on Google Maps and see how they are related to the territory.

In our libraries, students use their smartphones to check the online resources and to reserve group study rooms. We are the first libraries in Spain to introduce the laptop loan service, and we created the UPC Digital Video Library, the UPC Open Courseware project, and repositories of examination papers, doctoral theses, bachelor's theses and dissertations. The list is endless. All these projects are related to the digital transformation of the library and the use of ICT.

Why am I saying all this? Because without the FIB it would have been impossible to carry out all these changes in our libraries. The professors, researchers, research groups, students and administration and service staff of the FIB have always helped and advised us. Interns from the FIB have carried out their bachelor's theses in fields related to libraries and management of documents and scientific information. Also, students of the FIB have planned and carried out innovative projects for our libraries, and many of them have ended up working for the Libraries, Publications and Archives Service.

The FIB has helped us position ourselves and will continue to drive the digital transformation of the UPC libraries, and I think this is because it is one of the best informatics schools in Europe. That's why the UPC libraries are privileged services!

Thank you, FIB, on your fortieth anniversary!

DÍDAC MARTÍNEZ
Director of the Libraries, Publications and Archives Service of the UPC
Barcelona, October 2018

I-1-1 / Counter or counting table

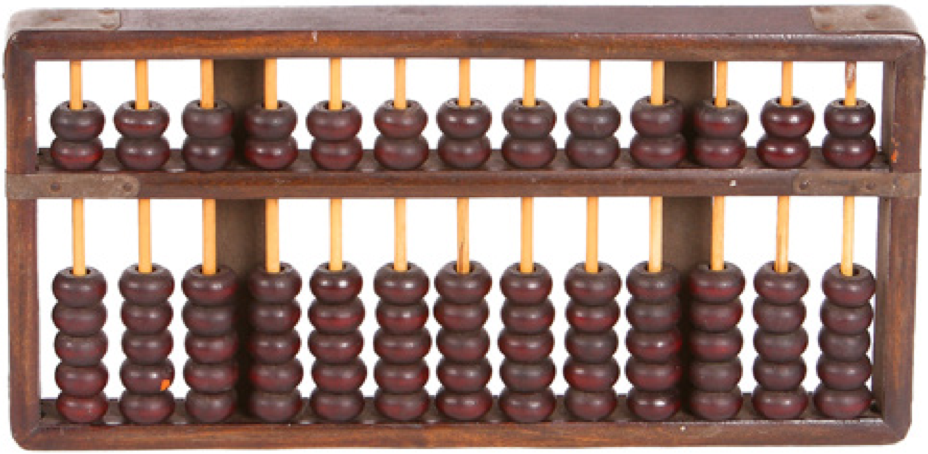
I / COUNTING

Counting must be one of the first and most basic numerical tasks humans learned to perform. To count, or reckon, people undoubtedly used one of the most versatile tools at their disposal: their own hands and feet, with their respective fingers, toes and phalanges. This explains the origin and persistence of the decimal numeral system we still use today.

In hunting, harvests, land dealings, bartering – in exchanges of all kinds – people had to learn to share their calculations so they could trust each other and record their transactions. They could do this by making notches on a stick, copying them on two parts that would be separated by breaking the stick to form a contract of sorts, a practice that is the origin of such seemingly modern expressions as "stakeholder" and "stock market", or "statistics". Alternatively, they could show their reckoning and count using small pebbles (*calculi* in Latin) – placed on the sand, a table or a counter – or by making lines on paper (I-1).

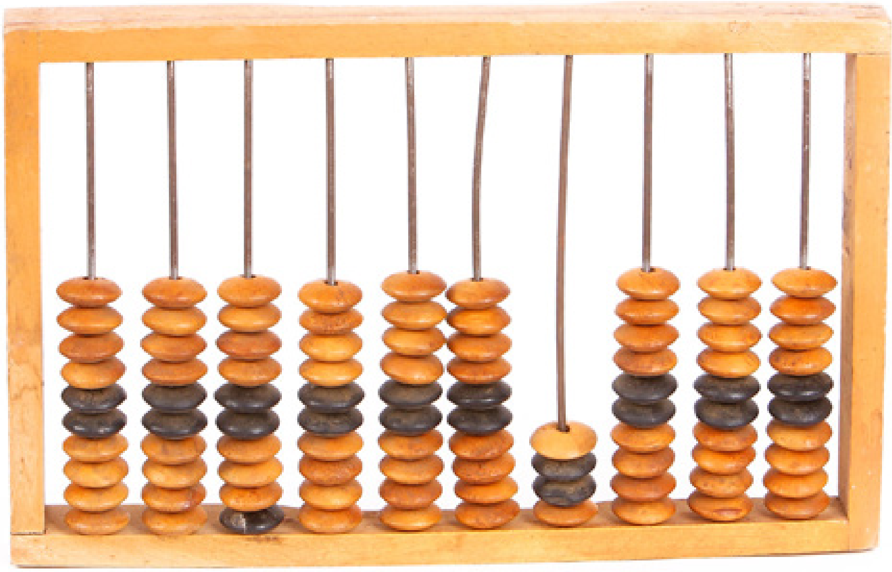
Over time, the pebbles went from the sand or table to being threaded on strings, sticks or wires in a portable frame: the abacus. There have been many versions of the device, from the Roman abacus to the main Chinese, Japanese and Russian variants (I-2), and this age-old tool is still with us today: millions of Asian schoolchildren continue to use abacuses to learn to count and to perform various calculations.

Meanwhile, in the West the inventiveness of the Industrial Revolution began to generate and popularise various devices that were used to count and avoid losing count (I-3, I-4). With the appearance of machines of all kinds – full of wheels, sprockets, axles and belts that had to be kept in sync – there was a great need for tools that could be used to count their turns, rotations and revolutions (I-5). When not everyone knew how to count and perform calculations, some could rely on books with predefined mathematical tables, which anticipated the coming of a numerical revolution (I-5-3).

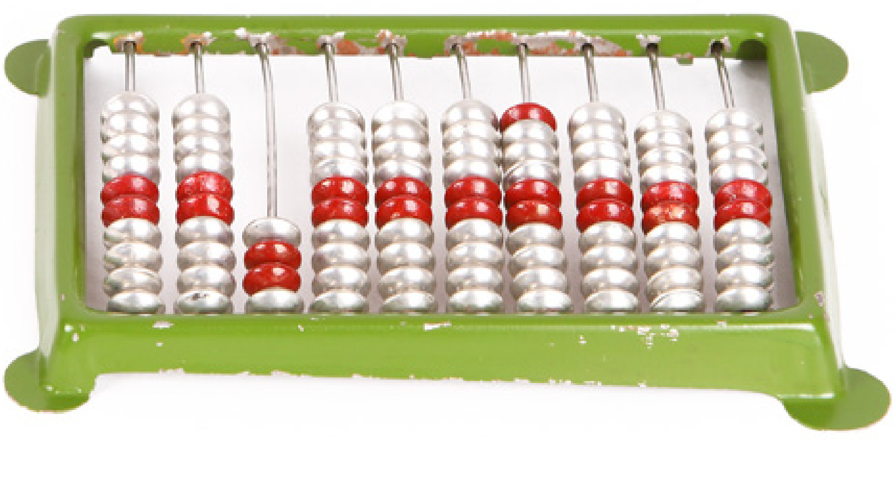


I-2-1 / Chinese abacus or Souanpan

I-2-2 / Japanese abacus or Soroban

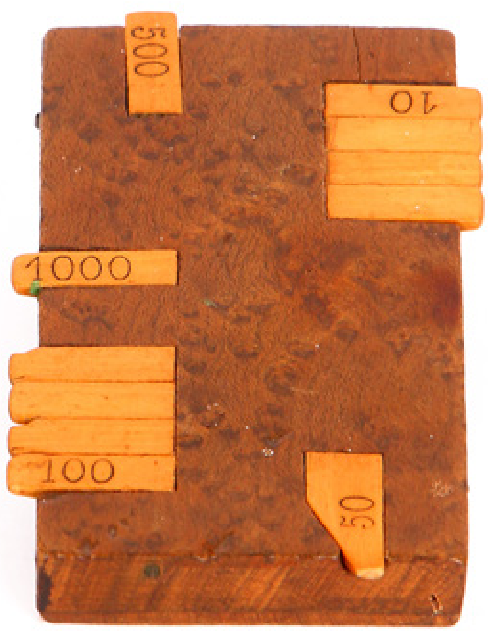


I-2-3 / Russian abacus or Stchoty



I-2-4 / Pocket abacus

I-3-1 / Circular thread counter, to remember

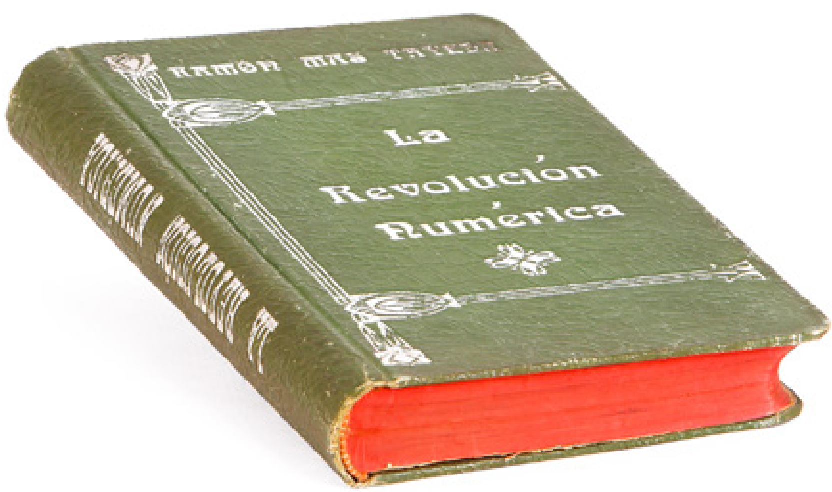


I-3-2 / Rectangular thread counter, to don't forget

I-4-1 / Comptator... the portable manual accumulator

I-5-1 / Analogic revolution counter

I-5-2 / Digital revolution counter



I-5-3 / Ready reckoner table book, to count and much more...

II / ADDING

Books containing precalculated results, known as “ready reckoners”, appeared after the invention of the printing press and were widely used from the sixteenth until well into the twentieth century. They included all kinds of precalculated values: sums, subtractions, multiplications and divisions – all organised in double-entry tables – as well as tables of percentages, interest figures, and special calculations for particular guilds or tasks.

During this period, some of the first devices invented with the aim of mechanising the most basic arithmetic operations (at least partially) were also popularised. Addition, the most basic operation and the basis of all the others, was the first challenge to which the early inventors and builders of devices, machines or engines – the first engineers – applied their learning and ingenuity.

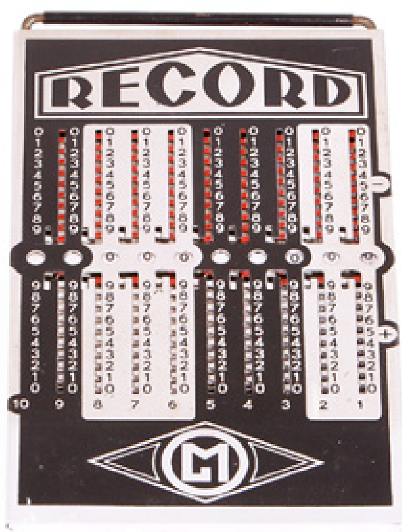
Among these early devices was the Addiator, also called the Troncet Type after its inventor. This popular portable device came in both pocket and desktop models for all kinds of business uses (II-2), and calculators of this kind were even given out as promotional gifts (II-1). When the sum of two digits was greater than ten, users had to perform the “carry one” operation themselves with a simple stylus movement. Other adding machines were operating using sliders or keys (II-3). But it was the mathematician and philosopher Blaise Pascal who in 1642 came up with a mechanical solution to the problem of carrying one, creating a device that became known as the Pascaline. The design of this calculator was the basis of most mechanical adding machines until well into the twentieth century. All devices of this kind were operated using a stylus inserted at points where digits were marked on their wheels (II-4).

Years earlier, another great mathematician, John Napier – best known as the developer of logarithms (a discovery he published in 1614), one of the conceptual tools that most dramatically revolutionised scientific calculation – also invented a small instrument for performing basic calculations, known as “Napier’s bones” (II-5).

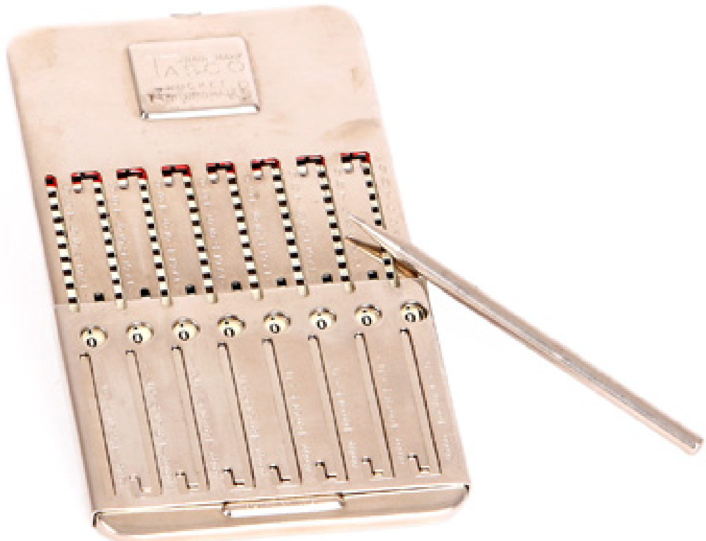
II-1-1 / Merchandising tronzet, from the Barcelona 1929 International Fair

II-1-2 / Merchandising booklet from the Barcelona 1929 International Fair

II-2-1 / Tronzet brand Business, never ever sold



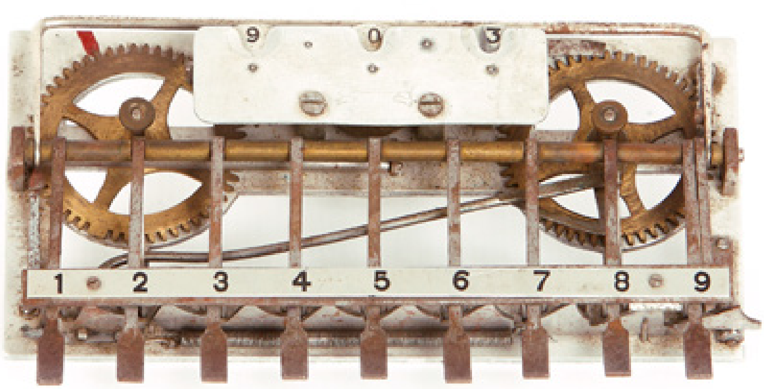
II-2-2 / Tronzet brand Record, white ones add and red ones substract



II-2-3 / Tronzet brand Tasco, the most brilliant one

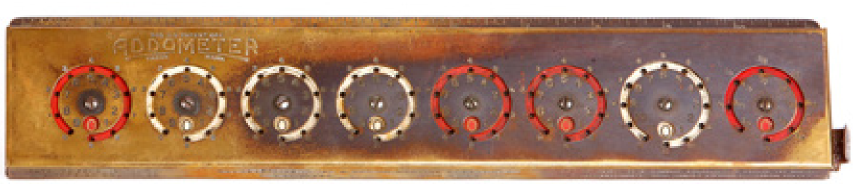
II-2-4 / Tronzet set brand Addiator, desktop type

II-3-1 / Personal chain adder brand Goldem Gem, for select offices and pockets



II-3-2 / Key-based adder brand Certa, the open mechanism that's always sure

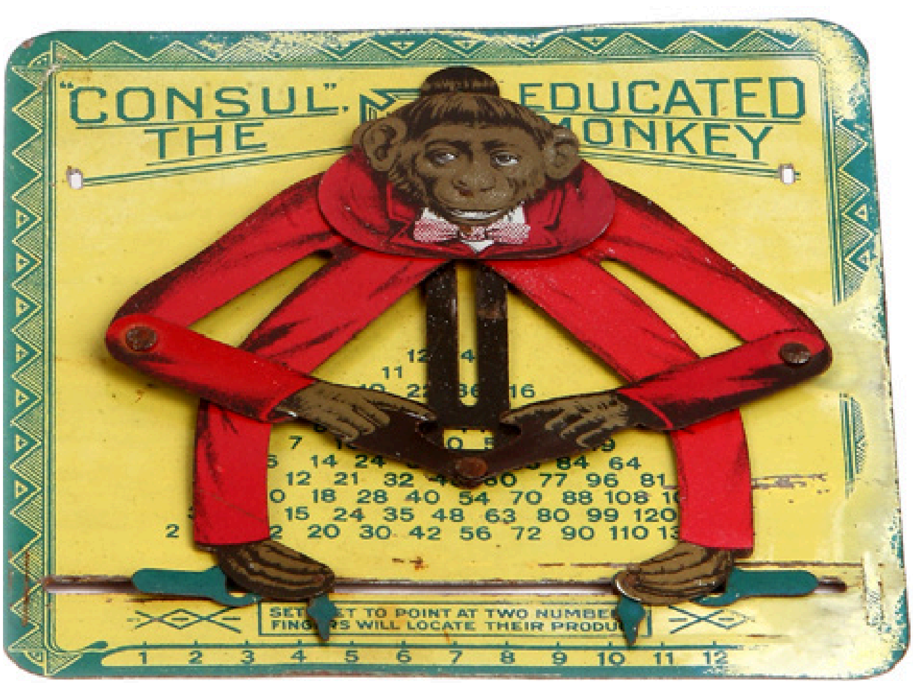
II-4-1 / Desktop adder brand Lightning, faster than lightning



II-4-2 / Desktop adder brand Addometer, the most popular one

II-4-3 / Pocked adder brand Shop'n'Add, to not overbuy

II-5-1 / Neper bones... Sticks to add, and much more



III-1-1 / Consul, the educated monkey, to play to learn to multiply

III / CALCULATING

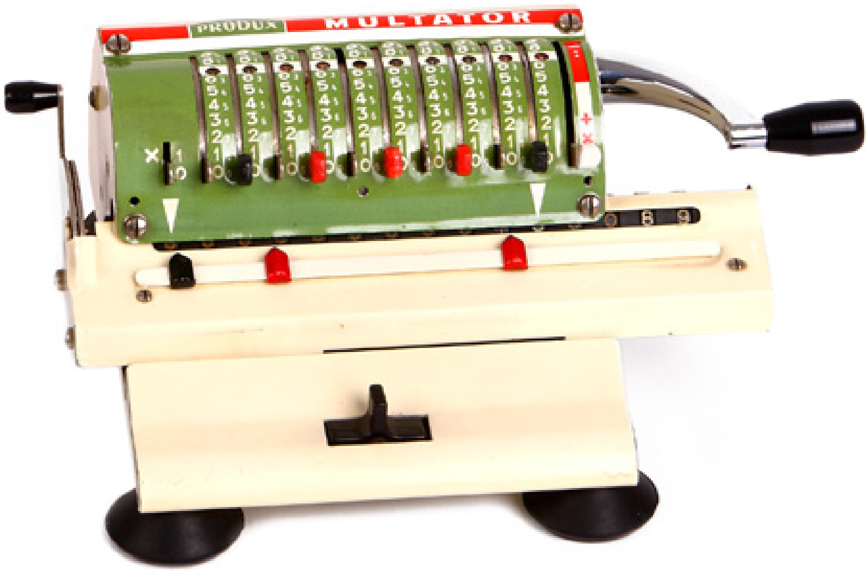
Counting and adding are the simplest operations, but they are the basis of all the other arithmetic operations. You can subtract by adding the additive inverse to a number, multiply using repeated addition, and divide using repeated subtraction. In school, we learn the multiplication table, procedures (or "algorithms") for adding and subtracting (if you know how to carry), and methods for multiplying and dividing. Sometimes children have even been able to practise using toys designed to make learning fun (III-1).

Historically, what was not so easy was designing and building mechanical instruments that could automate all these arithmetic operations (partially or completely). The earliest such device, which disappeared for centuries, was a calculator constructed at the end of the seventeenth century by the mathematical genius Gottfried Leibniz, who also laid the foundations of modern calculus, or mathematical analysis. Somewhat earlier, in 1673, he had invented the basic mechanism of his calculator, the Leibniz stepped drum, which served as a model for later calculators, including the handcrafted devices of the eighteenth century and the industrially produced calculators of the nineteenth and the first half of the twentieth century.

Following the commercial success of the Arithmometer (invented by the Frenchman Charles X. Thomas de Colmar) and its many successors, in the mid-twentieth century, the limits of mechanical calculation were reached with the astonishing Curta (III-2). The device, which marks the apogee of miniaturisation in pre-electronic calculators, was popularly known as the *pepper grinder* due to its appearance. After addition had been automated, the names of devices began to call to mind other arithmetic operations (III-3), and their physical forms became more varied (III-4). Eventually, devices that could be used to print operands and results appeared (III-4-3). For individual uses of a more demanding and professional character, some manufacturers developed more robust portable calculators (III-5).

III-1-2 /Arithmetic Quiz, to learn the four numeracy rules

III-2-1 / The amazing Curta... or the “pepper grinder”



III-3-1 / Multator, pin wheel calculator

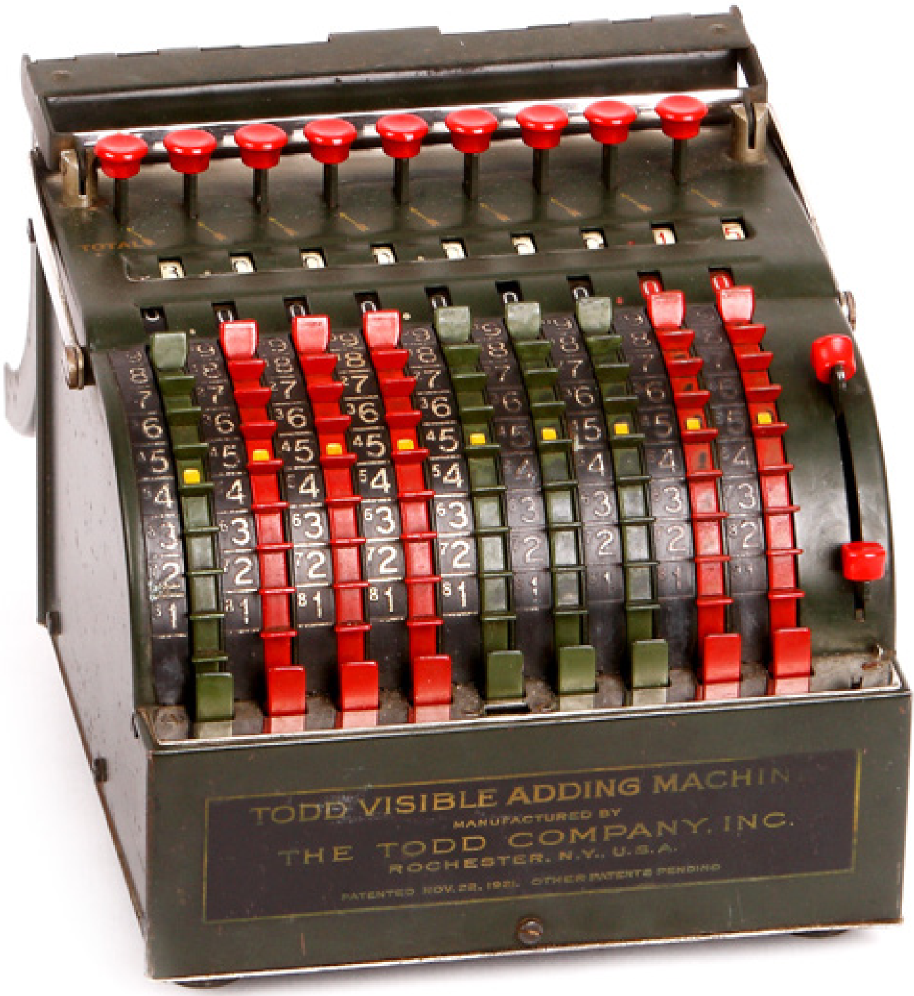
III-3-2 / Denominator, for adding payments and change returns

III-3-3 / Multor, pocked multiplying wheel

III-4-1 / Figure-8-Adder, the eight fitted for the hand

III-4-2 / Optima circular calculator

III-4-3 / Scribola adder-lister, the adder than prints



III-5-1 / Todd, portable blade adder, the one for professionals

IV / ACCOUNTING

From the sixteenth century, following the discovery of America, the world gradually became more interconnected. Maritime navigation and piloting grew from the eighteenth century, thanks in large measure to more precise surveying calculations, facilitated by logarithms developed in the seventeenth century and books of logarithmic tables, which were published and continuously updated by notable mathematicians.

The growth of the population, industry and trade also gave rise to a need to count, calculate and record all the events and activities these phenomena entailed (births, deaths, purchases, sales, collections, payments, taxes, etc.). In the case of financial transactions, records expressed in both units and economic terms had to be kept in account books, which were first used in the administration of the Spanish Empire of the sixteenth century. This was the origin of accounting, or bookkeeping, which continued to evolve from that point on. The work of keeping accurate accounts required specialised calculation and accounting machines that needed to work as efficiently as possible.

Calculators like those made by the company TIM (Time Is Money; IV-1) were based on the Leibniz stepped drum. They could only be made smaller through new innovations, such as the pinwheel calculator, invented simultaneously by Baldwin in the USA and Odhner in Europe (IV-3), and the Comptometer, a device made by Felt & Tarrant – with keys that could be pressed simultaneously for faster operation – that achieved great commercial success (IV-5).

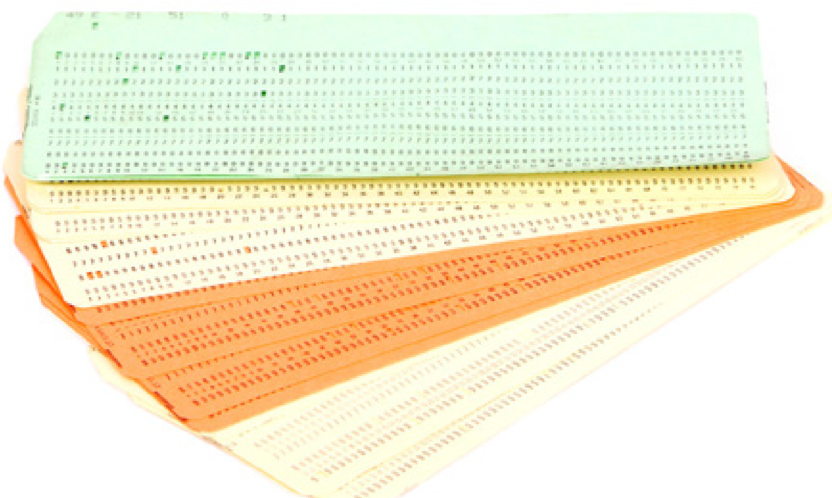
In addition to calculating, companies and public authorities wanted to record, encode, classify, analyse and tabulate their data, and they needed to perform these actions in the most efficient way possible. New inventions were needed. This time they were inspired by another innovation that dated to the early days of the Industrial Revolution – the Jacquard loom – whose movement was programmed using a series of punched cards (IV-2-4). This approach inspired Charles Babbage to design the input system for his Analytical Engine, the first mechanical forerunner of present-day computers, and for which Ada Lovelace thought up ways to program and use the device.

Half a century later, in the late 1800s, Hermann Hollerith developed an accounting system for the 1890 US census that used punched cards (IV-2). The new system revolutionised public statistics and marked the dawn of the data processing age. His initiative eventually led to the founding of IBM, which grew quickly as a supplier of data processing equipment and ended up taking the lead in business computing for decades.

In the context of a drive for rationalisation and business efficiency, the Taylorism that prevailed in early twentieth-century industrial enterprises led managers and owners to seek approaches and mechanisms for measuring and monitoring the time spent on all operations. This led to the development of the computus clocks, which were used to measure the duration of operations and synchronise tasks (IV-4).

IV-1-1 / Cursor calculator TIM-1, from Time Is Money (Leibnitz stepped reckoner mechanism)

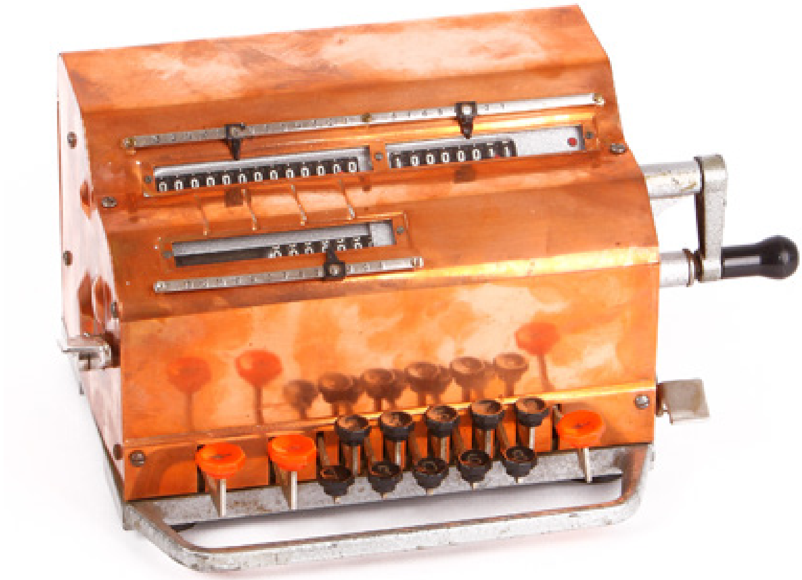
IV-2-1 / Keypunch, first automatic punchcard perforator, by Hollerith



IV-2-2 / Punchcards of type Hollerith-IBM, with 80 columns

IV-2-3 / IBM type punchcard press cylinder

IV-2-4 / For Jacquard looms, punchcard based weaving program



IV-3-1 / Key based FACIT calculator (Baldwin-Odhner pin wheel mechanism)

IV-4-1 / Calculagraph... to account for modern times

IV-4-2 / Watch-computus for night watchmen, segurity registered at puched disks

IV-5-1 / Comptometer from Felt-Tarrant... the revolutionary accounting efficiency

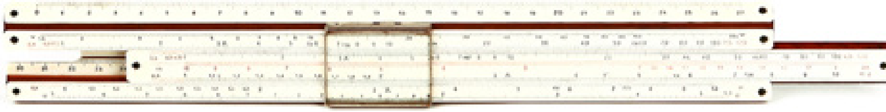
V / COMPUTING

It seems that it was IBM, in the context of its initiatives to encourage computer-related university training and research, that came up with the term "computer science", though this is just one of the names applied to the discipline over its 70-year life. Other terms that have been used with a similar meaning informatics, include cybernetics, automation, electronic brains, computers and electronic data processors, among many others.

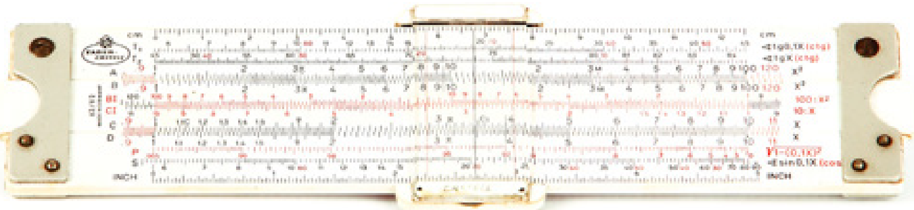
However, before modern computers were developed, people were already using instruments with pre-computed calculations. Usually these were analogue (non-digital) devices. The slide rule is undoubtedly the most successful analogue computer. Based on Napier's logarithmic calculation method, the instrument was developed by William Oughtred, among others, in the seventeenth century. Up until the 1970s, scientists and engineers enjoyed showing off their slide rules and used them with pride: it was a skill that not everybody had the intellectual ability to master (V-1).

Many slide rules were used to do calculations of all kinds, but some were designed for special purposes. Of these specialised slide rules, perhaps one of the least known is the sector, invented by the great scientist Galileo for use in the construction of military fortifications and citadels, and in navigation (V-2). As the use of slide rules grew, some calculations, because of their length or the degree of precision they entailed, could not be performed on a simple pocket slide rule; they required the use of highly sophisticated variants with scales arranged in spiral form to make optimal use of the space on the device (V-3).

In the twentieth century, long after the days of Galileo's sector, the need for devices that could perform special calculations arose once again. The instruments developed in response included planimeters – instruments for automatically calculating surface areas that automated the mathematical integration of two variables – and various instruments designed for other specialised tasks, such as telemetry in automotive racing, and air navigation (V-5).

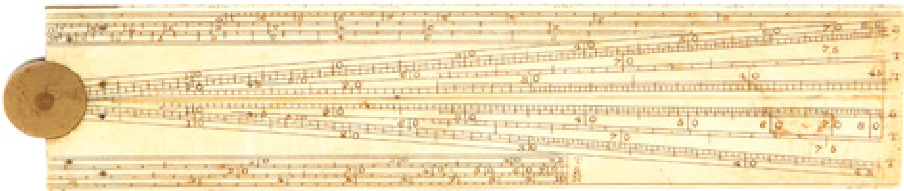


V-1-1 /Nestler sliderule for logarithmic computations

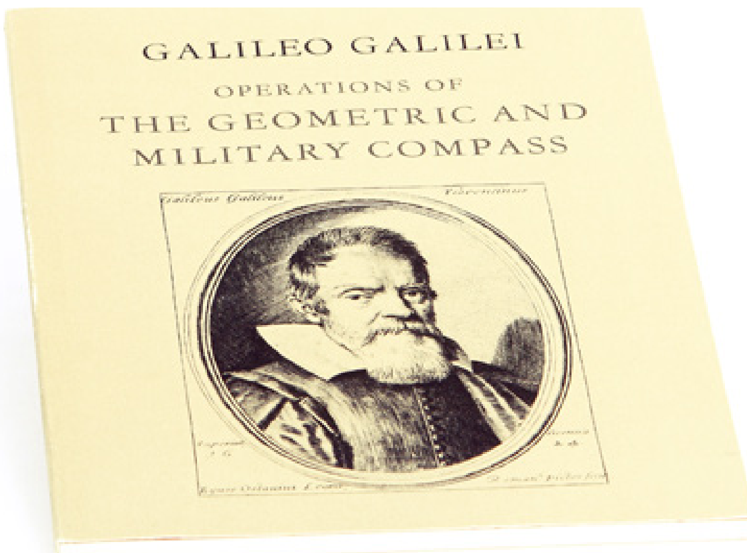


V-1-2 / Faber sliderule for logarithmic computations

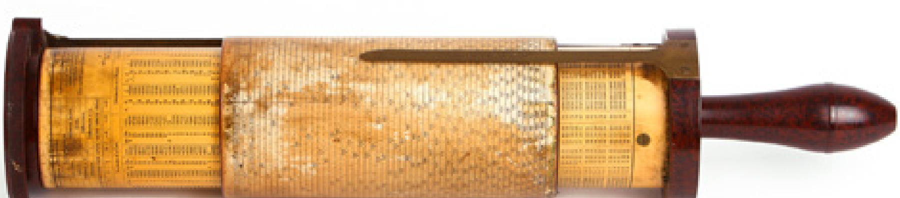
V-1-3 / Aero circular sliderule



V-2-1 / Galileo's compas or sector, computing rule for construction and navigation



V-2-2 / User manual for Galileo's sector (contemporary facsimile edition)

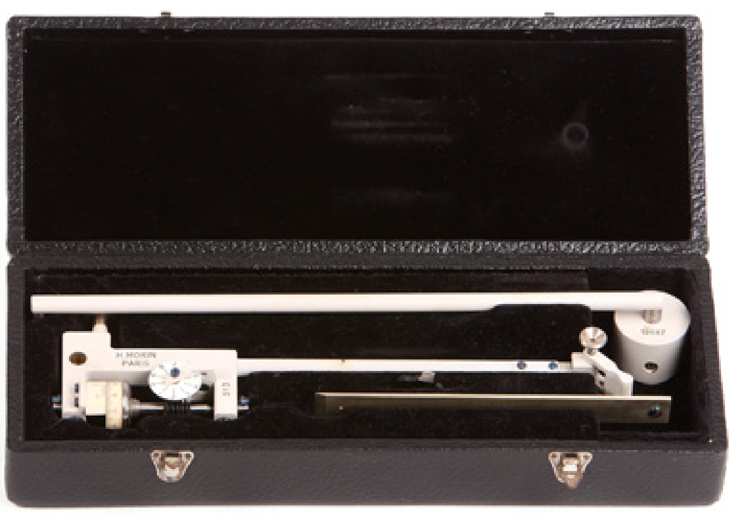


V-3-1 / Fuller desktop spiral rule, for logarithmic supercomputing

V-3-2 / Tröger circular rule

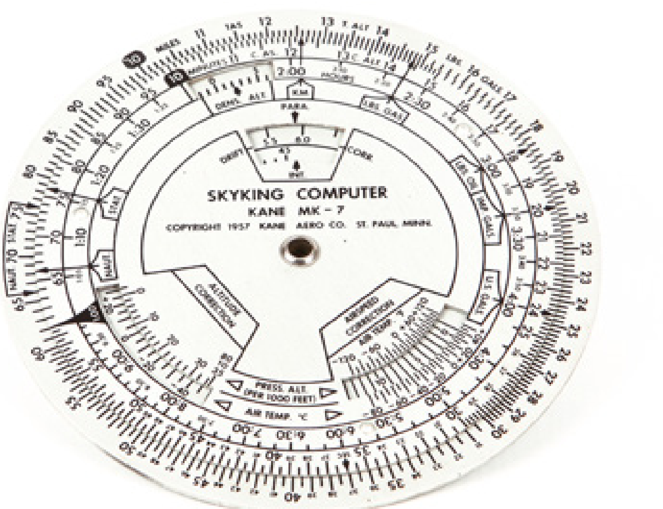
V-3-3 / Otis Kings portable rule, for logarithmic precision computations

V-4-1 / Planimeter, for the automatic computation of areas



V-4-2 / Morin planimeter, mechanizing mathematical integration

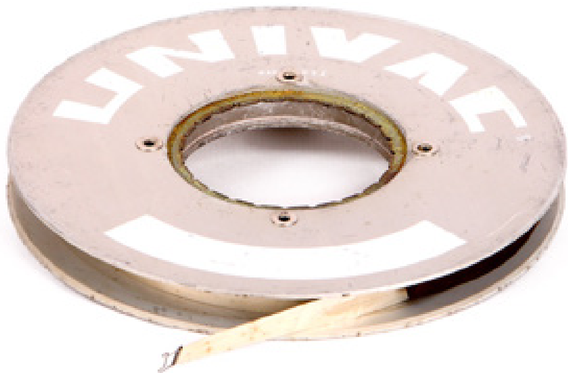
V-5-1 / NASCAR Computer Pack, for special purpose racing computations



V-5-2 /SkyKing Computer, for flying navigational computing

V-5-3 a / Electronic calculators do arrive

V-5-3 b / Electronic calculators stay for long



VI-1-1 / Original UNIVAC tape reel, with metal magnetizable suport

VI-1-2 / Original UNIVAC portfolio, for executive operating system routine libraries

VI-2-1 /Security patch, with an antique IBM logo

VI / COMPUTERISING

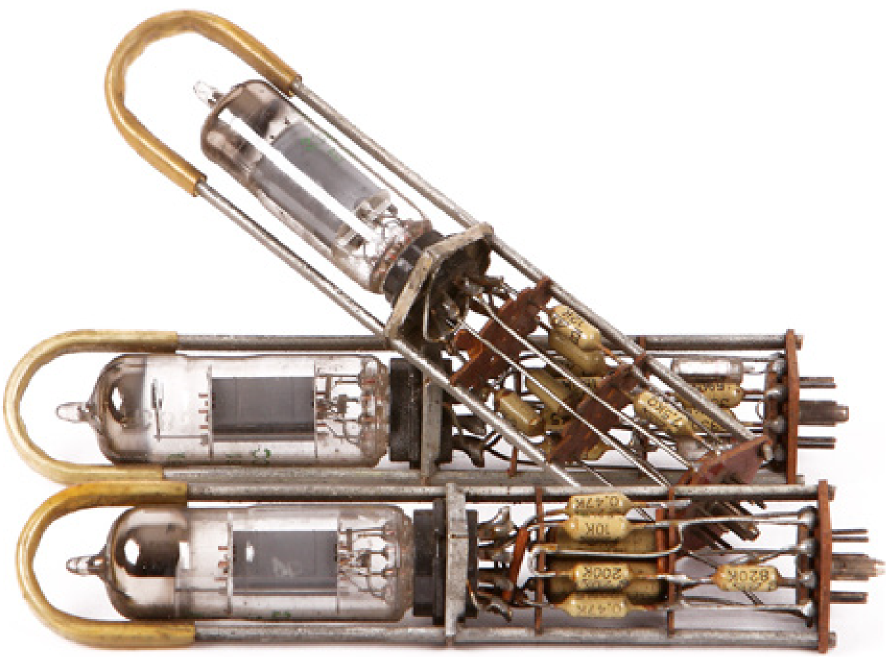
One way or another, all these developments bring us to the early days of modern computing. The accumulator register of Leibniz's calculator, Jacquard's loom, Babbage's engines, Hollerith's machines, the rules of Boolean logic – all this and much more, in an age of automation and impelled by the pressures of the Second World War, paved the way for the birth of modern computers.

All that was left was to overcome the physical limitations of mechanical technologies. And inventors and scientists began to achieve this, first with electromechanical technologies (relays), then with electrical systems (vacuum tubes), and finally by electronic means (transistors, integrated circuits, miniaturised integration, integration on a large scale, integration on a very large scale, etc.). After the first experimental computers (ABC, ASCC, etc.) and the first computers for war-related uses (ENIAC, Colossus, ACE, etc.), the first machines for scientific computing (EDSAC) appeared. Almost all these early computers aspired to be general-purpose devices – "universal machines".

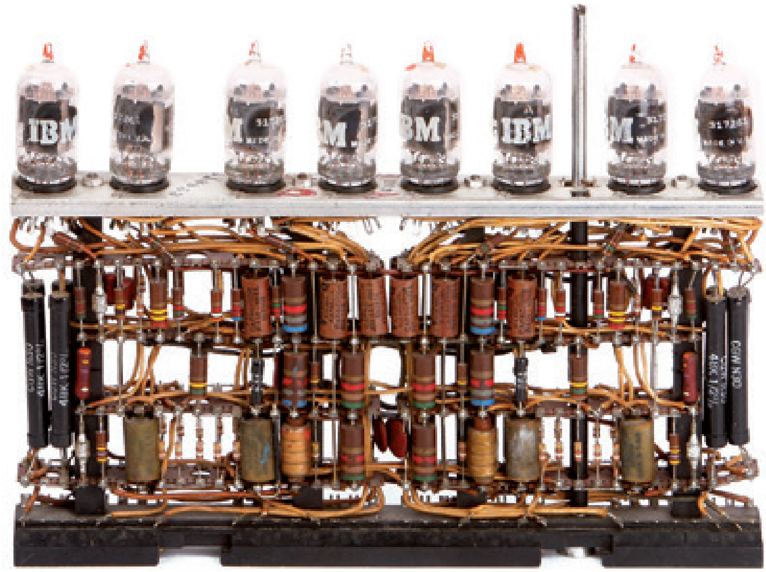
Two of the first computer scientists, J. Presper Eckert and John Mauchly (both ENIAC engineers), soon decided to make the leap to the business world. In 1950, they designed the first general-purpose commercial computer: the UNIVAC I (Universal Automatic Computer I). UNIVAC was known, amongst other things, for its innovative approach to secondary storage, on magnetic tapes and in program libraries with predefined routines (VI-1). Thanks to the work of the engineer Grace Hopper, UNIVAC was also the starting point for the definition of programming languages and for innovation in this area.

After resting on its laurels for some time, IBM, the company that dominated the business data processing market at the time, finally decided to start manufacturing computers. The company began by equipping some of its punched card processing systems with processing power and later designed completely new computers using circuits implemented with vacuum tubes (VI-2). In just a few years, the race to innovate was under way. Core storage was one of the major advances (VI-3), and programming based on physical arrangement of wires and hardwired routines (VI-4) was a forerunner to present-day software.

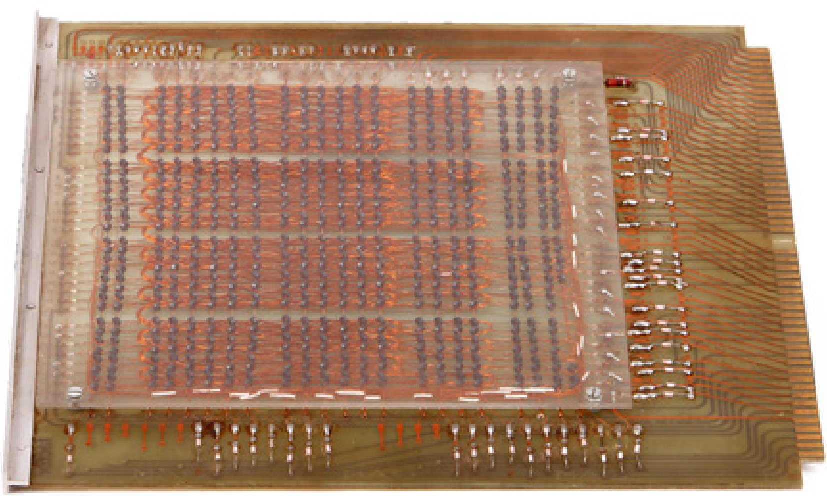
The first big electronic computers of the 1940s and 1950s caused both amazement and widespread fear. People were astonished by the lightning speed at which these "giant electronic brains", as the media called them, were able to solve complex problems, and frightened by the possibility that they might be used to control all aspects of our activity (VI-5).



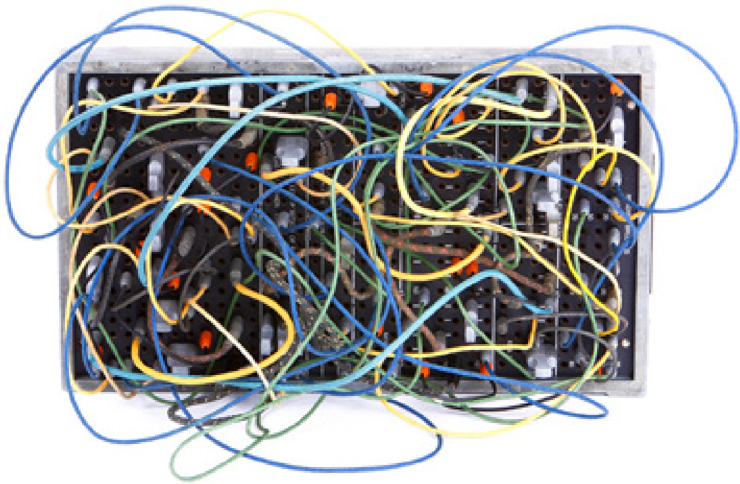
VI-2-2 / Pluggable bits (3 bits) from an IBM 704



VI-2-3 / Pluggable board for a byte (8 bits) from the IBM 650

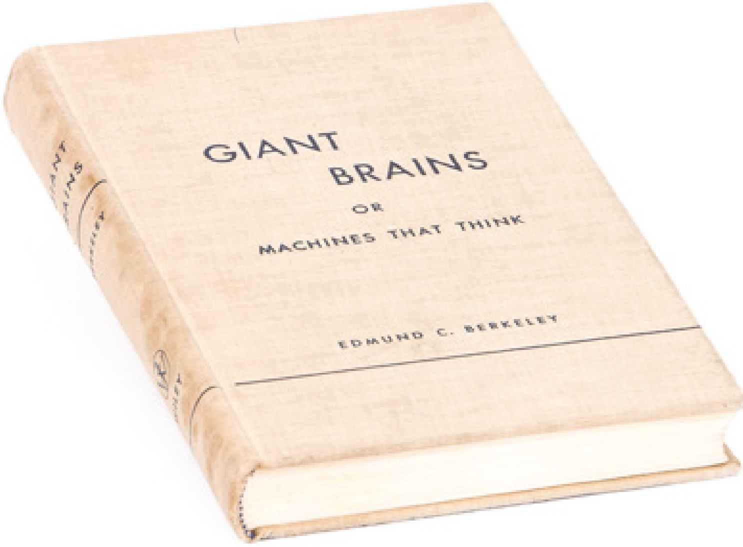


VI-3-1 / Big core memory board from Empsa

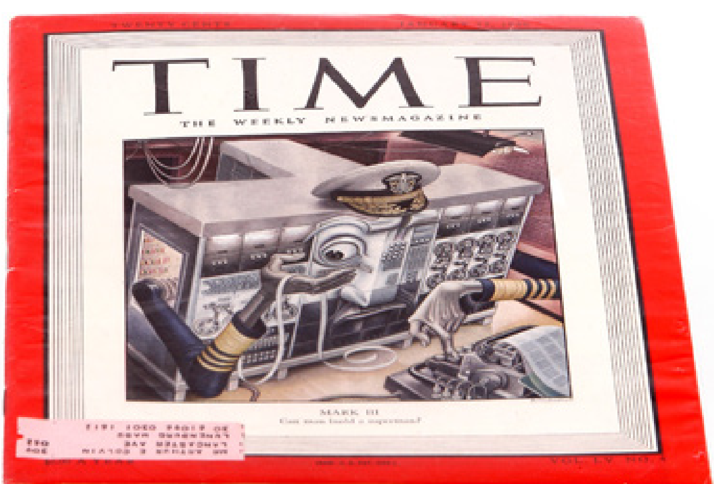


VI-4-1 / IBM cable based programming board

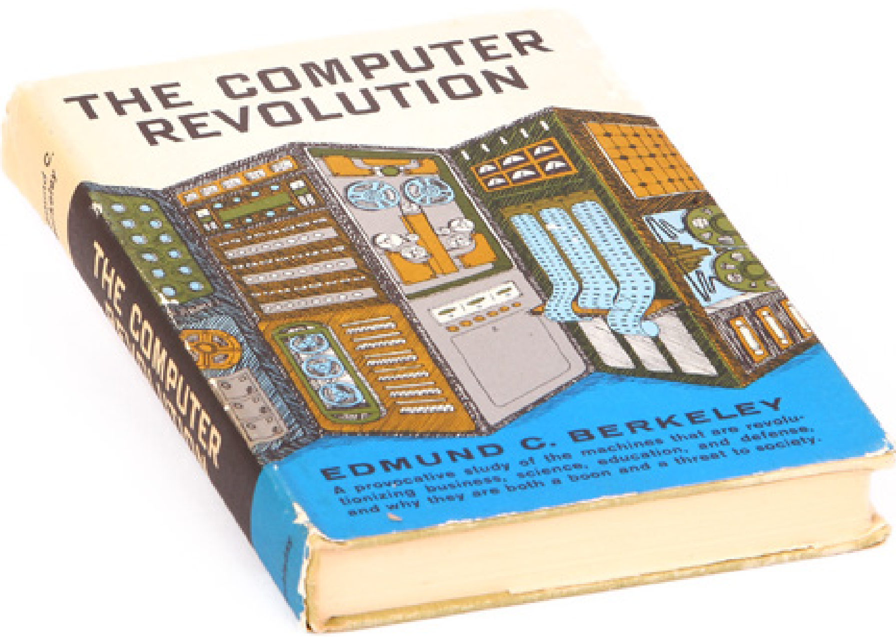
VI-4-2 / Burroughs functional pluggable board by hardware



VI-5-1 / Electronic Brains from E.C.Berkeley, the first book of computer divulgation



VI-5-2 / TIME magazine cover page, ¿the super-brain that will control everything?



VI-5-3 / The Computer Revolution, de E.C.Berkeley, the revolution that is comming

VII / COMMUNICATING

It is curious how today, 80 years after the appearance of the first automatic computers, millions of internet-connected computer devices that are the descendants of those digital dinosaurs continue to astonish us with each new generation of products (laptops, tablets, smartphones, digital watches, etc.), and how we continue to fear the control we may end up being subject to as users of these tools.

The telecommunications, radio and television systems that preceded the first computers and contributed to their emergence are now fully digitised and operate based on computer systems. Traditional analogue telephones (VII-1) and telephone exchanges operated by long rows of young women (VII-4) are now objects of nostalgia that have been superseded by digitised systems. The security systems companies use for their transactions have also evolved, with the progressive digitisation of what were once rudimentary commercial protection systems (VII-2). More recently, we put away our film-based still and movie cameras (VII-3) in favour of their digital descendants. And the same fate has befallen the analogue devices we once used to play music or copy and print information (VII-5).

In a very short time, all these analogue technologies have been digitised, miniaturised and integrated. In other words, they have been turned into individual computerised systems (phones, televisions, watches, computers, etc.) that are connected and synchronised by means of other, large-scale computerised systems that remain out of sight (servers, server farms, the cloud, supercomputers, etc.) – all operating and communicating with each other at unimaginable speeds.

What is paradoxical and at the same time romantic about all these interconnected computer systems operating at light speed is that deep inside, in their processors and memories, they continue to translate all the data they handle into long strings of zeros and ones, lists that they ultimately subject to innumerable binary sums.

In this light, if we look beyond speeds and interfaces, sizes and forms, perhaps computing has not changed that much since the emergence of the first modern computers eight decades ago, or travelled so far from the earliest inventions and concepts related to mechanical calculation -at least not in its essence.

VII-1-1 / Analogical telephony, and its cables, arrive everywhere, homes and companies

VII-2-1 / Protectograph... mechanism to ensure security to banking transactions

VII-3-1 / Kodak photographic camera, the power of images... in black and white

VII-3-2 / Brownie mechanical filming camcorder, from Kodak... color in movementt

VII-4-1 / Phone central switching board… where everything can be known

VII-4-1 / Headphones

VIII / POPULARISING

Today, thanks to the so-called "digital revolution", we live in a globalised, automated and interconnected world underpinned by thousands of computer and telematic systems, a world that offers us great collective and individual power. For example, smartphones and social media, among many other services based on digital technologies, are rapidly transforming our habits. These new tools have even facilitated social uprisings and the emergence of new governments and parties, new ways of collaborating, learning, playing and interacting – new ways of living.

But it was not until the late 1970s – and especially the 1980s and 1990s – that the use of computer tools began to spread beyond large companies and government agencies as they became more affordable, first for smaller organisations, and then for the rest of the population.

After the first experimental computers of the 1950s, 1960s and 1970s, large mainframe systems, made by companies like UNIVAC and IBM, appeared and began to dominate the corporate market. This was also the period when the first operating systems and high-level programming languages – Fortran, COBOL and ALGOL, among many others – came into use. At the same time, a new generation of minicomputers, developed in university research environments and made by manufacturers like DEC, HP and Data General, put computers within reach of medium-sized companies and government agencies, and university institutions. This development also brought new languages and operating systems, including Lisp, C and Unix.

But the real explosion would not come until the late 1970s and the 1980s, when a small group of restless young computer scientists, imbued with the free spirit that characterised the hippy movement and the student protests of 1968, came to see computer technology as a tool for experimenting and achieving the freedom they longed for. These young men and women, who were knowledgeable about and critical of corporate computing, set out to experiment and create new computer systems for individual and group use – tools that would be affordable and accessible to many more users.

What started in the 1970s with a group of hobbyists who took a home-brew approach to building computers – sharing problems and solutions at get-togethers with other enthusiasts – was carried forward by the first entrepreneurial initiatives. Some of the most powerful companies in the contemporary world, including Apple and Microsoft, got their start during those years in garages and other bare-bones premises. Although this movement was strongest in California, similar things were happening in other places around the world.

In January 1975, the MITS Altair 8800, now regarded as the first computer for personal use, was featured on the cover of *Popular Electronics* magazine. The Altair 8800 was a limited microcomputer and highly technical, but it was embraced by hobbyists because of its relative affordability. Other systems soon followed, including Radio Shack's TRS-80 (VIII-1), which began finding its way into American homes in 1977, and Atari's specialised gaming systems (VIII-2). That same year, Apple Computer, a young company set up by two friends, Steve Jobs and Steve Wozniak, launched its Apple II computer (VIII-3), which is considered the first truly personal computer, or PC. The new Apple product was marketed to a wide spectrum of users and featured its own operating system, which differed from those of other products. Soon afterwards, microcomputers destined to become commercial hits were put on the market, including the Commodore 64 in 1982 (VIII-4), which beat its rivals on memory and peripherals, and the dynasty of Spectrum computers (VIII-5).

Surprised by the growing popularity of such small systems, and having gained a fairly secure position in its business markets, the multinational IBM, which was the dominant manufacturer of computer systems, finally decided to invest in the new category of personal computers. This led to the appearance in 1981 of the dazzling IBM PC (VIII-6), which, thanks more to the reputation of the IBM brand than to its technological features, immediately became the preferred personal computer for companies and many users and the de facto standard in the category.

In the early 1980s, the runaway success of the IBM PC led to the emergence of many companies, such as Amstrad and Olivetti (VIII-7), which manufactured IBM PC clones that sold at significantly lower prices. Ancillary businesses also grew. They included makers of electronic components – producers of chips and processors, such as Intel, Motorola and AMD – and software manufacturers, such as Bill Gates' Microsoft, which brought out its first DOS operating systems and programming languages for PCs. The first portable computers also appeared, among them the Osborne 1 in 1981 and the Compaq Portable in 1982. By that year, a bit more than five years after the first personal computers had come on the market, over 5 million PCs had been sold worldwide. The impact of this phenomenon was so significant that Time magazine named the PC the "Man of the Year" in 1983. It was the first time in the magazine's history that the designation did not go to a public human figure.

And just when it looked like the IBM PC was set to remain the market leader and secure the largest share of the market in the category for IBM, accompanied on this occasion by Microsoft, another surprising development changed the direction of personal computing once again. After some false starts and an intense effort on the part of a highly creative team of computer scientists led by Steve Jobs, Apple Computer, the company that had created the category, launched its first Macintosh, or Mac (VIII-8), in 1984. This new kind of personal computer was presented to the public as a device created to free users from the yoke of systems made by Big Brother, IBM.

The fact is that in creating the Mac, Apple had drawn inspiration from systems and solutions proposed in previous research, mainly by the Xerox PARC team – Adele Goldberg, Lynn Conway, Alan Kay and Robert Metcalfe, among others – who had in turn built on ideas developed by pioneers like Douglas Engelbart of Stanford University. We still benefit today from the design features that the Macintosh began to popularise: operating systems based on icons and the desktop metaphor, the mouse, object-oriented programming languages, computer networks, and a long et cetera. PCs paved the way for the development of the internet and the web just a few years later, which in turn made possible the "digital revolution" we are still living through 35 years later.

VIII-1 / Radio Shack TRS-80, invaged US homes for “war games”

VIII-2 / Atari... the most multi-purpose home microcomputer

VIII-3 / Apple II... the first marketed computer which was truly personal

VIII-4 / Commodore 64... the best domestic micro computer ever sold

VIII-5 / Spectrum micro computers... the british saga from Lord Sinclair

VIII-6 / IBM Personal Computer... the answer from the giant Big Blue which filled companies

VIII-7 / Olivetti Quaderno... the most compact portable PC clone

VIII-8 / Apple Macintosh... the PC with principles which revolutionized the future

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