Early Italian computers: Pier Giorgio Perotto's P101

Massimo Guarnieri

This historical column follows the article on Mario Tchou's ELEA 9003 that was published in the previous issue of this magazine and tells events that developed in that same Olivetti company. We known that much of the early progress in personal computers took place in the US, and particularly on the West Coast in the early 1970s. Nevertheless, trailblazers were exploring the field elsewhere even earlier, and an important step forward was taken in the Olivetti company, about ten years before, with the creation of a small desk computer, a device that incorporated a number of features which later had to became common in personal computers.

Pier Giorgio Perotto

Pier Giorgio Perotto (Fig. 1) was born in Turin on 24th December 1930, and graduated in electrical engineering from the Turin Polytechnic in 1952, where he obtained a second degree in aeronautical engineering the following year. Later, he collaborated in research on aerodynamics at the Polytechnic and was appointed to a teaching position in mechanics at the age of 27. In the meantime, he was recruited by carmaker Fiat (now Fiat Chrysler Automobiles, FCA) in 1955. Perotto moved to the Olivetti Company in April 1957 and joined the LRE (Laboratorio di Ricerche Elettroniche, i.e. Electronic Research Laboratory) in Barbaricina, where he was involved in the construction of the ELEA 9003 [1]. In 1958, he was charged with designing the punched-tape-to-card converter or CBS (convertitore banda scheda), a device for interfacing the electronic calculators with mechanical machines. A similar device was the punched-tape-to-magnetic-tape converter or CBN (convertitore banda nastro) that was developed by the group led by Ivo Mazzanti in 1959. These

machines aimed to interface the Olivetti's traditional electromechanical products with an ELEA computer, thus reducing the distance between the two product lines.

Conceving a novel computing concept

Perotto was working in the DEO (Divisione Elettronica Olivetti, i.e. Olivetti Electronic Division) when this was disbanded by Olivetti and incorporated into OGE (Olivetti General Electric) in 1964 [1]. However, he showed reluctance to enter the new company, and DEO leader Roberto Olivetti (1928–1985), Adriano's son, arranged to keep Perotto and a small group of engineers and technicians at Olivetti, with responsibility for marginal electronics activities and, in particular, to work on an embryonic project. In Spring 1962, Roberto Olivetti had asked Perotto to undertake a feasibility study of an electronic calculator with automation capabilities. Perotto conceived a more ambitious, almost clandestine project. This was a small, user-friendly programmable electronic computer, not as fast and powerful as a mainframe, but suitable as a replacement for the early electronic calculators of the day, which underperformed with respect to traditional mechanical models. Perotto wrote later: "I dreamed of a friendly machine to which to delegate the operations producing mental fatigue and error, a machine that could docilely learn and then perform, that stored data and simple and intuitive instructions, whose use was within everyone's capacity, cheap and the same size as other office devices which people already used. I had to create a new language that did not need the white-coat interpreter" [2].

Perotto not only needed to develop the design, but also to convince the conservative company's top management of his idea, and with this aim he decided

to build a real prototype, assisted by a few co-workers taken from the group of electronics experts still at Olivetti. The project was primarily developed by Perotto, Giovanni De Sandre (b. 1935) and Gastone Garziera (b. 1942). Fig. 2 shows the three men with Giancarlo Toppi (b. 1944), who also contributed marginally. Other technicians involved in the final stages of the project were Giuliano Gaiti (1941–2012) and Eduardo Ecclesia. Their device had to be capable of executing complex algorithms with conditioned jumps while being easy to program by unskilled users. It also had to be small in size and low priced. At that time, integrated circuits already existed, as the germanium mesa type had been invented by Jack Kilby in 1958 and the manufacturing-suitable planar version by Bob Noyce in 1959, with a major contribution to p-n junction insulation by Kurt Lehovec in late 1958 [3]. However, they were still costly and unreliable, and hence the printed circuit board technology with discrete components was adopted for the electronic circuits [4]. Silicon transistors were chosen, which were emerging as more resilient and temperature-tolerant than germanium ones, so that no room conditioning would be needed. The circuitry exploited an innovative manufacturing process based on sub-circuits organized into 945 “micro-modules” (which included a total of 938 semiconductor devices, with 653 transistors and 285 diodes), an architecture conceived and patented by Perotto and Eduardo Ecclesia in 1964 [5]. The cutting-edge technology for dynamic memory at the time was the magnetic-core memory, but this was expensive. Instead, Perotto chose a much cheaper technology, an alternative concept for computers that was within Olivetti’s manufacturing know-how. It consisted of a “delay line” exploiting the magnetostrictive effect, that was implemented as a 6.5-meter steel wire coiled with a diameter of 15 cm and provided

with two transducers (one for writing and one for reading) that had a capacity of 240 eight-bit characters (1920 bits in total) and a cycle time of 2.2 ms. For the mass memory, Perotto invented a new removable device, the “magnetic program card”, which consisted of a mylar board of approximately 5 cm $\times$ 20 cm in size, coated on one face with a magnetic layer, and with the other face available for annotations (Fig. 3). It is considered a forerunner of the floppy disk, which was developed by IBM in 1968. On each of its two sides, it could store data and programs and had a capacity of 120 instructions (i.e. 120 characters) or a combination of data and instructions. Different cards could be used to upload different programs written by users or stored in a card library. This was a groundbreaking concept for the time, as it allowed anyone to execute programs within a few seconds. The mechanical structure and components were developed by a group led by Franco Bretti from 1963 and included the 37-key keyboard (for data input), the magnetic card reader/writer and the miniaturized drum printer (for data output). This printer was capable of printing programs and results onto a paper tape at a relatively high speed of 30 characters per second. Both I/O devices and the card reader/writer were integrated within the computer. This machine could perform the four arithmetic functions, square roots, absolute values and fractional parts, and was equipped with memory registers with functions such as clear, transfer and exchange, as well as printing and halt for input. A completely new programming language was developed that operated at machine level but was much simpler and more intuitive than the existing machine codes, allowing it to be used by non-specialized users. It controlled exchanges between the memory and calculation registers, and the operations within the registers. Based on only 15 intuitive instructions, it was a kind of dedicated BASIC

(the real BASIC – Beginner's All-purpose Symbolic Instruction Code – was contemporarily developed by Thomas E. Kurt and John Kemen at Darmouth College, Hannover, New Hampshire, in 1964). Conditional jumps, a numeric-symbolic programming language, internal memory, and a data storage system made the machine a real "computer", even if it lacked an operating system and a monitor, as was the case for all computers of the time. It had a size of 61 cm $\times$ 48 cm $\times$ 16 cm, a little larger than a typewriter, weighted 35 kg and consumed 350 W.

The prototype was ready in the fall of 1964, and was presented to the company's top management later that year. The entire device was patented by Perotto and De Sandre in March 1965 [6], and the two inventors ceded the rights to Olivetti for one dollar, in compliance with the company's policy. The device's original and appealing look (Fig. 4) was conceived by Mario Bellini, a young architect possibly introduced by Ettore Sottsass, after an earlier and cumbersome design by Marco Zanuso had been rejected. Bellini's design was patented in 1967 [7], and has been exhibited in several museums, including New York's MoMA. The device was given the name Programma 101, which was soon shortened to P101, but to the Olivetti staff it was the Perottina, after the name of its inventor.

The success

With the prototype completed in 1964, the Programma 101 was presented at the BEMA exhibition in New York in October of 1965, at the suggestion of Olivetti's marketing director Elserino Piol (b. 1931). The small room in which it was exhibited soon became crowded with visitors eager to see and test its few prototypes, which were provided with some demo programs. In subsequent days,

visitors, uninterested in the company's mechanical products, had to queue in a very long line to see the P101. According to some reporters, the Olivetti's stand was the most visited of the exhibition. The machine achieved the same success at exhibitions in Moscow in December 1965 and Milan in April 1966. The American press bestowed unusual honors on the small Italian machine, hailing it as the first desktop computer in the world. On October 23 1965, Business Week ran an article on P101: "Olivetti Underwood Corp has developed a desk-top computer that's truly small enough to fit on top of a desk. About the size of an office typewriter, it is classified as a computer because it does such tasks as payroll computation and interest calculations by referring to an internally stored program. Called the Programma 101, it is priced at $3,200. …" [8]. Two days later The New York Journal–American wrote: "We may see a computer in every office even before there are two cars in every garage … a desktop computer which business can use and own outright" (Fig. 5) [9].

The device was industrialized for mass production within a very short time in 1965, despite the company having dismissed almost all its electronics staff. To this end, a number of issues had to be fixed quickly, and the delivery of 100% tested units required that Perotto and a few other co-workers personally checked each unit produced to ensure full customer satisfaction with the first P101s, which were sold in the US for US$3,200 each (US$26,310 in 2019 terms). The P101 marked a groundbreaking step in desk computing, as it was able to execute in half a second an operation that required 30 seconds on a traditional mechanical calculator; it bridged the gap between these calculators and mainframes, while offering the highest density of computing power at the time. Other personal computing machines that started appearing at around the same time showed inferior performance or much

higher prices. One example was the Mathatron, which was halfway between a programmable calculator and a personal computer; this was announced in November 1963 and was priced from US$5,000 in 1966 (corresponding to US$39,950 in 2019 terms) [10]. The PDP-8, the cheapest DEC computer at the time, was much more expensive; it was marketed at US$18,500 (US$152,120 in 2019 terms) in March 1965 and sold more than 50,000 units [11]. A few years earlier, in 1957, IBM had tried to launch the 610 PAC model, which was specifically designed for individual computing, but its low performance and high price (US$55,000, corresponding to US$506,390 in 2018 terms) limited its sales to 180 units. In 1959, IBM introduced the 1620 model, which was produced in 2,000 units and leased for a monthly rate of US$1620.

The P101 is often considered the first fully successful personal computer; with 44,000 units produced and delivered, initially almost all in the US, it was an important, profitable product for Olivetti. It could be used in accounting, financial analyses and scientific computing; an early example of the latter case is given in [12]. NASA purchased about 10 P101s and used them in the Apollo 11 mission that landed on the Moon on July 21, 1969. NASA engineer David Whittle stated in 2006: “By Apollo 11, we had a desktop computer, sort of, kind of, called an Olivetti Programma 101. It was kind of a supercalculator. It was probably a foot and a half square, and about maybe eight inches tall.” [13]. IBM bought several units to investigate the technology. In 1968, Hewlett Packard released the HP9100 model, a desktop computer inspired by the P101 that used the same magnetic card and architecture, for which they paid US$900,000 (US$6.36 million in 2018 terms) in royalties to Olivetti in 1969 [14, 15]. The P101 became a case study at the Harvard School of Business. Notably, the P101

was launched more than ten years before the Altair 8800, Apple I and Microsoft BASIC were developed, when Bill Gates and Steve Jobs were no more than nine years old.

Evolution in Olivetti

Olivetti was then at the cutting edge of the still embryonic sector of distributed human-sized computing, while the major computer companies, with IBM at the helm, headed toward mainframes with increasing computational power. Olivetti had the possibility of maintaining a leadership position in the rising sector of desktop computers. Instead, the P101 remained an isolated case for some years at Olivetti. The top management, oriented more toward traditional mechanical devices, remained unenthusiastic and unconvinced of its potential until 1967, the year HP9100 was launched. As a result, the company was not able to convert quickly its production from the declining mechanical computing sector to electronics. For the sake of example, the prototype of the Logos 328 electronic calculator was ready in 1966, but the device was not produced and marketed until 1968. In fact, like many other Italian manufacturing companies, Olivetti was then focused on the dominating issue of the clash between capital and manpower, leaving no space for visionary inventor-managers at the top management levels. On the other hand, Perotto was not able or was not in a condition to start a new specialized company to exploit the technology he had invented, as younger people such as Bill Gates and Steve Jobs did some years later; Italy was, and still is, far different from the West Coast of the US.

When Perotto was eventually appointed to head the Olivetti Research and Development department in April 1967, competitive foreign devices had already started appearing on the market. He maintained this position until 1978, guiding the

company's belated transformation from mechanics to electronics. It took almost five years to produce new advanced products. When sales boomed, OGE's skilled electronics employees were recruited, as this company was in the process of shutting down in 1970. Based on the P101, versions P102 and P203 were developed; the former were provided with external connection capabilities (after a request by the British Army) and the latter, launched in 1967, was capable of producing accounting documents for business use. Perotto also directed the development of the personal computers P6060 and P6040. The former, based on the Olivetti TTL circuit UC1009 and featuring a 32 alphanumeric character plasma display, was launched in 1973 and was presented at the Hanover Fair in March 1976. The latter, which used the Intel 8080 and a LED bar display, was ready in 1978. Other projects led by Perotto included the ET 101 of 1978 (the first electronic typewriter), the Logos calculators line, and the TC800 "smart" terminal.

Perotto's later years

When the company underwent reincorporation in 1979, Perotto was appointed the president and CEO of ELEA SpA, a company within the Olivetti group that was committed to consultancy and educational activities. He held this position with outstanding success, fusing his management expertise with his humanistic vision of technology and society. He published books and handbooks on these topics. In 1991, he was awarded the Leonardo da Vinci Prize for the design of the P101. Perotto left Olivetti in 1993 and was appointed the vice-president of SOGEA (a School of Business Management) in 1996. In addition, he funded and headed the

consultancy firm FINSA (Future Innovation Business Strategies). He died from cancer in Genoa on 22nd January 2002.

Acknowledgments

I am indebted to dr. Gastone Garziera, who provided me with a wealth of invaluable details on the birth Programma 101. As a young technician, he was a key assistant of Perotto in the design of P101. For his contribution to the birth of personal computing, dr. Garziera was assigned the honorary master degree from the University of Bari, Italy, in October 2019.

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Figures

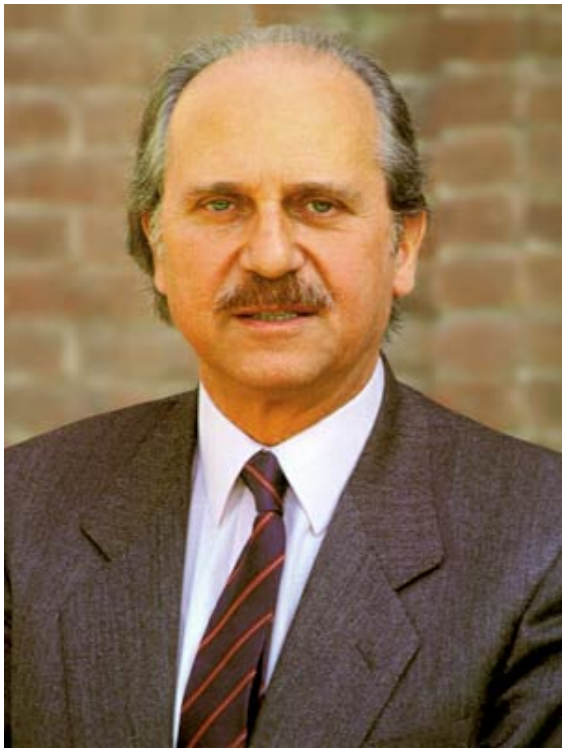

Fig. 1 – Pier Giorgio Perotto (1930–2002) in his later years (courtesy of Pierpaolo Perotto)

Note: email permission to publish released by Pierpaolo Perotto

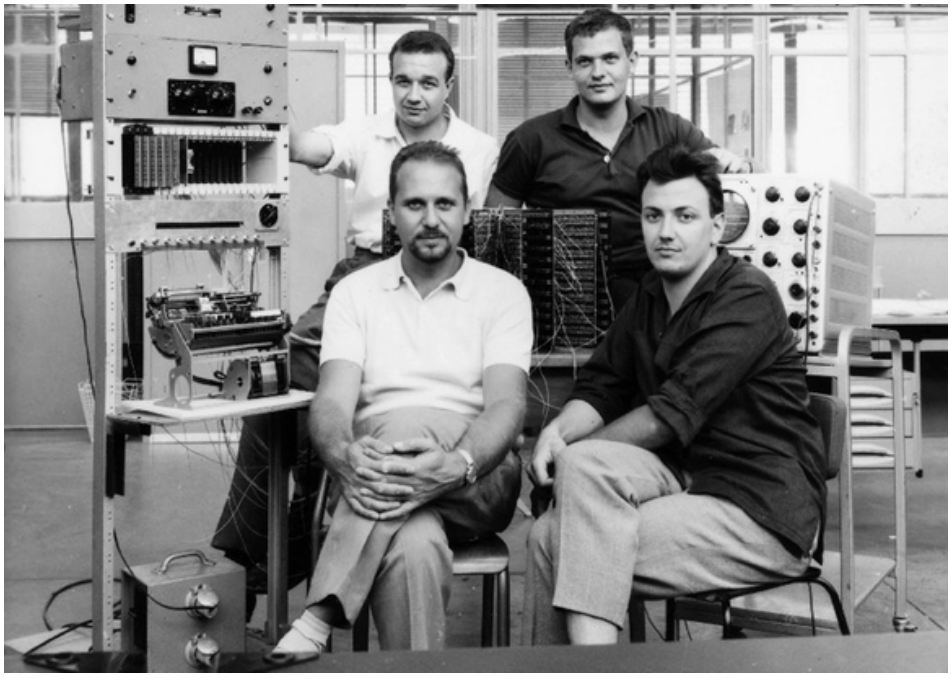

Fig. 2 – Pier Giorgio Perotto (front left) with the other designers of P101, in August 1964: Gastone Garziera (top left) and Giovanni De Sandre (front right). The fourth man is Giancarlo Toppi, who had marginal involvement (courtesy of Wikimedia Commons)

Note: picture in the public domain: https://en.wikipedia.org/wiki/File:P101_team_-_Pier_Giorgio_Perotto,_Giovanni_De_Sandre,_Gastone_Garziera,_Giancarlo_Toppi.jpg

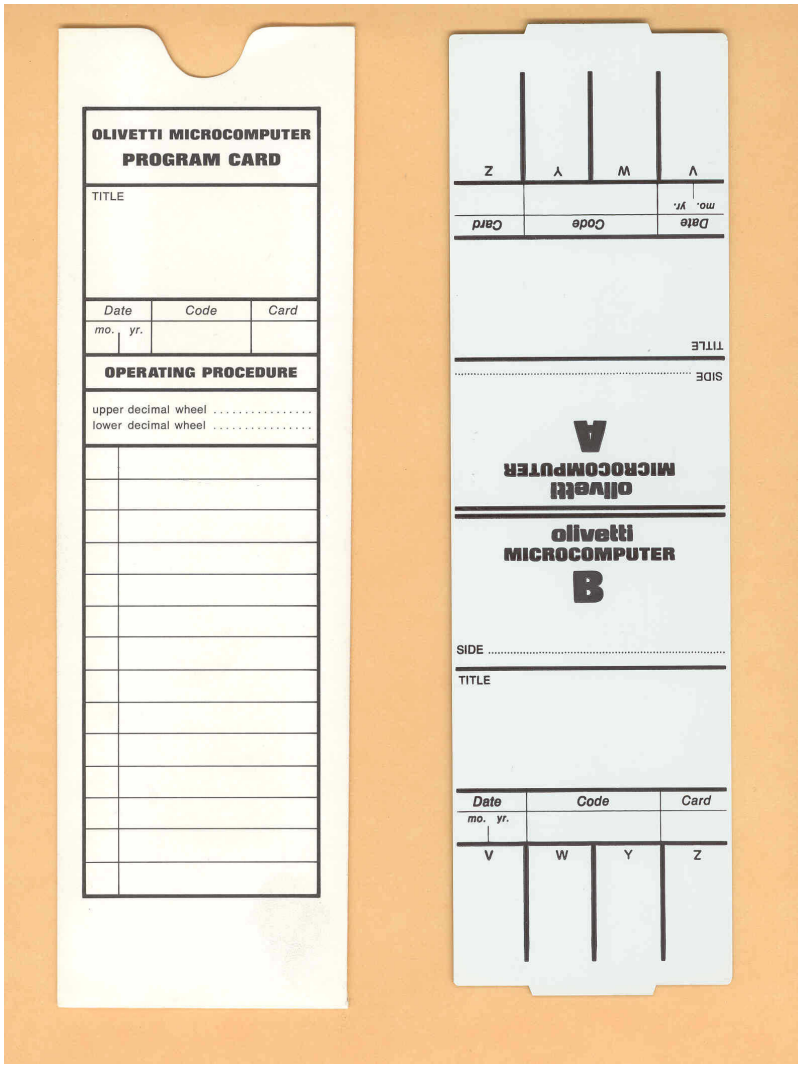

Fig. 3 – A magnetic program card for the Programma 101: envelope and front with annotation space. The reverse had a magnetic coating (photo by Alfredo Logioia at Curtamania.com).

Note: email permission to publish released by Curtamania.com

Fig. 4 – Perotto's Programma 101 (P101), presented in 1964 (courtesy of Museo della Scienza e Tecnologia, Milan, Italy)

Note: email permission to publish released by Museo della Scienza e Tecnologia, Milan, Italy

WALL STREET JOURNAL
DALLAS, TEXAS

OCT 15 1965

Desk-Top Size Computer Is Being Sold by Olivetti For First Time in U.S.

By a WALL STREET JOURNAL Staff Reporter

NEW YORK—Olivetti Underwood Corp. is offering its first computer for sale in the U.S.

A small desk-top computer for business and engineering use with sale price of $5,500 was introduced by the company at a press conference.

Olivetti Underwood, a U.S. subsidiary of Ing. C. Olivetti & Co., S.p.A., of Italy, said the computer has the power to make logical decisions. It uses a program card for insertion into the machine to perform operations.

The company said it expects the new computer to fill a gap in the market between desk calculators and large computers.

A calculating machine and an electric typewriter were also introduced.

BUSINESS WEEK

October 23, 1965

Fifty cents

A McGraw-Hill publication

'Desk-top' computer is typewriter size

Olivetti Underwood Corp. has developed a desk-top computer that's truly small enough to fit on top of a desk. About the size of an office typewriter, it is classified as a computer because it does such tasks as payroll computation and interest calculations by referring to an internally stored program. Called the Programma 101, it is priced at $5,200.

A payroll clerk would put a magnetic program card in the machine; as many as 120 instructions for such jobs are preprinted on each card. Then the clerk would keypunch in an employee's earnings, and the machine would print out programmed deductions for taxes, medical plans, and the like. End

BUSINESS WEEK October 23, 1965

New York Journal American

NEW YORK'S LARGEST EVENING NEWSPAPER

MONDAY, OCTOBER 25, 1965 21

A DESK TOP COMPUTER

We may see a computer in every office even before there are two cars in every garage.

This outlook for business machines drew near reality this week when Olivetti Underwood unveiled PROGRAMMA 101 — a desktop computer which businesses can use and own outright.

A manager can now have his secretary pro-rate the expenses of all departments in a company with instant speed at her own desk. Other fundamental business applications like amortization, mortgage, and payroll are also easily computed on PROGRAMMA 101.

November 11, 1965 • ENGINEERING NEWS-RECORD

Keyboard Computer Sits on Desk

The Olivetti Underwood Corp. has introduced a desktop computer that the company says will bridge the gap between desk calculators and full scale computers.

It is a keyboard-operated machine that prints input data, instructions and answers at the rate of 30 characters per second. Programs involving up to 120 instructions may be entered manually through the keyboard, or, if it is a program that is used repeatedly, it may be fed to the machine automatically from a coded magnetic card.

Once programmed, the machine will solve a problem when the variables are entered on the keyboard; no operation instructions are needed, the machine follows the program, printing out the answers automatically.

The machine can solve differential equations, bessel functions and perform numerical integration. Spokesmen for Olivetti Underwood say the machine's program language is extremely simple and can be learned by anyone familiar with mathematical calculations in a very short time.

In addition, the company is developing and will maintain a library of standard programs in most fields of mathematics, including engineering.

The machine can be bought outright for $3,200 or leased on a monthly basis. Olivetti Underwood Corp., 581 Capitol Ave., Hartford, Conn.

COMPUTER can take 120 instructions.

Monroe's River Daily
NEW YORK, N.Y.

OCT 15 1965

Desktop Computer Introduced by Olivetti/Underwood

DAILY NEWS RECORD
NEW YORK, N.Y.

OCT 15 1965

Olivetti Launches New Dimension In Computers

Fig. 5 – Reactions of the American press to the presentation of the Programma 101 at 1965 BEMA in New York (courtesy of Pierpaolo Perotto)

Note: email permission to publish released by Pierpaolo Perotto