A History of Pocket Computers 1980-2000

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***Abstract** - Pocket computers are a category of personal computer. A complete computer system in a small battery powered package that slips in your pocket, it has all the elements needed for writing and running programs. They are reliable, affordable and useable by persons with minimum knowledge. Applications benefit from quick, on-the-spot data gathering, validation, analysis. Learning to program was simple and easy with the manuals supplied with them.*

***Keywords** -* miniature computer system, learning programming BASIC SHARP CASIO H-P Panasonic Canon "pocket computers", point-of-use,

. I. INTRODUCTION

The Pocket Computer is a battery-powered hand-held computer system. Small in size, lightweight, durable, reliable, and low-cost ($100-200.) It was designed as a complete system with immediate access to its programs, data, and functions.

Pocket Computers are a category of computing history that seems little covered by museums and publications about computers. They are important because their designers put together devices with every development about building computers known at the time: low power CMOS and NMOS chips and LCD displays, high quality miniature tactile keyboards and tiny input-output interfaces. Pocket computers had everything in a handy unit. Simple. Low-cost. Ideal for small scale computer systems development.

Pocket computers were first marketed worldwide by the SHARP Corporation of Japan in 1980, who engineered many kinds over the next twenty years. They were bought for several reasons, during the same time as "personal" computers also came into popular use and pocket calculators became commonplace.

A pocket computer is ready to use instantly when switched ON. It has all the familiar alphabetic and numeric keys, a display with large bit-mapped characters which are easy to read. Power from coin-size cell batteries gave operating time typically 150-300 hours, which gave several years useage. Memory for programs, for data, for reserved functions was retained in the computer and immediately available. A built-in connector to attach accessories - printer, cassette recorder interface, level converter cable - made it easy to exchange data and to enlarge memory capacity. Clear instructions to write programs together with libraries of sample programs helped even non-technical persons gain familiarity with writing software to help them automate complex or repetitive tasks.

In professions and business applications, procedures, pricing, policies, or technical skills that were programmed into a pocket computer could be carried anywhere, and distributed to associates for 'customer facing' negotiations.

Programs developed for "point-of-use" applications were an important market. The benefits of small scale, portability and low-cost meant that pocket computers could be economically distributed by organisations to their employees working anywhere. The value to the organisation was the assurance that the input data was verified, the calculations were correct, and the options, procedures, policies that had been programmed were stepped through correctly.

. II. THE ROAD TO POCKET COMPUTERS

Computation has been necessary for a long time to help the individual and to help the enterprise. Machines to help the individual at the point of use: typewriters, slide rules, mechanical comptometers, electric and electronic calculators. In large organisations systems were needed for recording transactions, gathering data, manufacture, control and administration. At first, human computers and clerical workforces were organised to do this[1]. Then tabulating machines. An advertisement in 1951 for the IBM 604 electronic calculating punched card machine pictured with an engineer holding a slide rule, promised that it could "speed through thousands of intricate computations so quickly that on many complex problems it's like having 150 extra engineers".

Pocket computers have a unique character - they were all battery powered, they were engineered as a complete computer system, a mainframe computer in miniature. They differed from "personal computers" and "programmable calculators" which came at the same time. Who bought them? Why were they better for some uses? How did they develop over twenty years. Why are they no longer manufactured?.

A. Calculating numbers - portable calculators at a price.

Electronic desktop calculators in the early 1960's used discrete components -transistors and diodes, magnetic core or acoustic delay memory soldered onto

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[1] David Allen Grier, *When Computers Were Human*, ISBN9780691133829, Princeton Univ. Press, 2007. Before Palm Pilots and iPods, PCs and laptops, the term "computer" referred to the people who did scientific calculations by hand.

circuit boards. Discrete components were later replaced by integrated circuit (IC) packages - many transistors etched onto a single chip.

In 1967 Texas Instruments applied for a patent for a hand-held battery powered calculator. The consumer electronics company, SHARP Corporation was also a leader in calculator and personal computer research and development.[E 1.] They made the first portable battery powered calculators -Sharp EL-8M, November 1970, "The smallest electronic calculator in the world". Hewlett-Packard was well known in the desktop mains-powered calculator market when, in 1972, they marketed the Model HP-35 shirt pocket sized calculator with advanced mathematical functions as a replacement for the engineer's slide rule. At $395. it cost fifty times as much as the slide rule!

B. Personal Computers become a reality

Computer-on-a-chip "microprocessors" were introduced to the market by several manufacturers: 1974 Intel 8080; 1975 Motorola 6800. Hobbyists saw the potential to sell kits for home assembly and soon a wide variety of 'home' computers appeared on the market.[2] Apple II (1977, $1,300.), Sinclair ($150.), Commodore VIC-20 ($300.), etc. To make them function, the user had to buy peripherals (data monitor or television adapter) and connect them. The low-cost "personal" computer became a reality.

C. The "Portable Office" -first battery powered portable personal computer.

By 1980 there were many examples of mains powered personal computers that squeezed everything into a self-contained heavy, "luggable" unit- Kaypro, Osborne, Compaq to name a few. The idea of a laptop was born. Probably the first complete portable "laptop" computer system that fit into a briefcase was designed in 1982 by an engineer from Sharp computer development group, Mr. Sadakatsu Hashimoto. The Sharp PC-5000, an A4/Letter size unit 5kg. including battery, 8-line LCD display, MS-DOS, fast N-MOS 8088 chip, "bubble" memory cartridges, optional built-in printer and optional built-in telephone/modem.[E 2.] It was commercially marketed worldwide in 1983 as "The Portable Office", complete with software for less than $2,000. The British magazine "Which Computer?", May 1984, article *The Portable Micro* compared it to the GRID PC which cost twice as much and needed mains power.[E 3.]

D. The first battery powered hand-held computer system

In 1980 the first hand-held battery powered

computer system, the SHARP PC-1211 was marketed worldwide. Figure 1 illustrate its size. The PC-1211 slides into the CE-122 printer cassette interface accessory. It is a slim and lightweight computer with one line 24 character dot-matrix liquid crystal display. With high quality construction, metal case, tactile feedback keys, it is very durable. For less than one hundred dollars, a complete portable system 170 grams including batteries which gave an operating time about 300 hours.

The BASIC interpreter programming language is built into the CPU so that it is instantly available. Writing programs, editing, and debugging them in a step-by-step way is made very easy by single keystrokes. The Sharp BASIC interpreter is a carefully engineered "structured BASIC" with many features not found elsewhere. [E 4.]

E. Several Manufacturers made Pocket Computers

SHARP had a worldwide consumer electronics business and was able to introduce pocket computers with some success in many markets around the world. They were not the only makers. Other Japanese manufacturers, notably Casio, Nippon Electric (NEC), Canon, Toshiba entered the market. A list of a few is presented in the Appendix. Some were licensed from the Japanese makers and marketed under different names.

To meet customer's special requirements SHARP Corporation introduced many variations.

III. THE MARKET FOR POCKET COMPUTERS

Around 1980 people around the world were curious about computers and often encountered them at work. Mini-computers became affordable for businesses, word processor machines began to replace office electric typewriters. Data communications that were done with telex and teleprinter could be done by microcomputers dialing up on telephone with modems or acoustic couplers.

Very few schools could afford their own computer. But their value in the classroom was recognized for teaching and for training pupils to use them in their future careers.

In the job market computer skills were in demand. As more people understood the possibilities, a large market grew for "home" and "personal" models.

Pocket computers had a unique but small market where portability, ease of use, and reliable operation were appreciated.

A. Pocket computers for learning to write a program.

In Japan, secondary schools and technical colleges were a large home market that gave manufacturers of consumer electronics a good reason to design pocket computers and invest in the expensive automatic machinery to build them in volume. (Japan has four times as many engineers per capita as does the United States.) Programmable calculators needed a deep

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[2] Michael Holley experienced the hobby, club and commercial spirit of that time. His website captures interviews with Daniel Meyer, a founder of Southwest Technical Products (SWTPC), and Gary Kay, designer of the SWTPC 6800, and his personal story "...by early 1977 I had a complete system running BASIC. I also attended the Homebrew Computer Club.". http://www.swtpc.com/mholley/History

understanding of their specific programming languages and operating logic and were popular with engineering and finance. The pocket computer, however, did not require a knowledge of the native instruction set of the CPU, nor the operating system. Most were programmed with BASIC, and run with a built-in interpreter, without need for compiling program instructions.

1980's parents wanted their children to grow up with the advantage of computer knowledge. The difficulty with introducing computers into schools was cost and practicality. Personal computers made this easier, but the variety of home computers had different hardware and intermediate software (Unix, MS-DOS, CP/M, etc.) that were not compatible. Learning computer programming can be frustrating and time consuming. The pocket computer was easier. Its BASIC interpreter is already in read–only memory (ROM), and is ready with a switch from RUN to PROGRAM mode.

Pocket computers came with a large library of application programs in categories useful in schools and professional studies: mathematics (solving algebra and geometry problems); engineering mechanics; finance - compound interest, annuities, tax rules; graphics; simulations; games. In France, Germany and other countries, local distributors had translations published in their languages. This was a practical way for children and adults to learn to write programs and put together a system to solve complex and repetitive tasks.

Teachers of mathematics reported the benefit of pocket computers teaching mixed levels of students in same class.[E 5.]

B. Business and Professional Uses

The concept of portable "information at point-of-use" had got off the ground with pocket computers. Thousands transformed their work by learning how to program work procedures automating them for themselves or others to use away from their office, possibly on-site field work, or facing their customers. Some started their own software businesses, to channel their knowledge by writing portable computer applications. "Value-added" resellers (VARs) found profitable niche markets designing business systems solutions which made use of pocket computers. A complete solution could be delivered for a few hundred dollars including the computer, which was reliable and could be used immediately without 'computer training.'

The following examples are from the 1982 catalogue *Micros For Managers*[3] that illustrate the optimism and

opportunity experienced by ordinary persons who bought a Sharp PC-1211, who learned to program it and then offered their application, recorded on cassette, for sale.

AUDIT work- Cash and Bank analysis into 20 columns, code sundries into user defined categories.£25. Written by a practicing accountant. **PocketTax** to calculate United Kingdom personal taxes in complicated corporate, expatriate environments.

PENSION - Calculates gross pension contribution refunds and P.A.Y.E, payments due, net refunds. Written by pensions administrator to your specific requirements.£50.

HVACDesign Package. Digitised standard heating ventilation, air conditioning (HVAC) charts and I.H.V.E. formulae. Defined keys call up eighteen design programs. Airflow for rectangular and circular ductwork, sheet metal weights, psychrometric chart, water and pipe weights, Any altitude. Written by an HVAC engineer. £25.

Celestial NAVIGATION. Automatic computation of ship's position from sextant reading on any two navigational stars. Solves dead reckoning , great circle, and rhumb line problems. Written by a retired ship's captain. £20.

General AVIATION. Pre–flight and airborne computations including true airspeed, mach#, true air temp.,density, altitude and wind drift. Long range navigation including dead reckoning, rhumb line, and great circle programs. Written by an airline pilot. £10.

The value of reliable data processing at point-of-use was documented in scientific journals of that time. An internet search brings up many examples telling how pocket computers were used in hospitals *(A New Aid to Nutritional Support),* in field measurements *(Pollen Count; Forage Selection)*, in political science (*Observational Methods in Political Research,*), etc.

PromSoft Inc.,Vermont, U.S.A. is an international business creating finance software tailor-made for customers around the world. During 1980's and 90's software was sold pre-programmed on RAM and ROM cards that fit in the Sharp PC-1270, a RUN only machine. That software is password protected, meaning it cannot be modified, copied, or erased. Although that model pocket computer long ago ended production, in 2019 PromSoft are still able to repair customers' PC-1270, while also offering their software for web, cloud, laptop, PC and iPhone.

IV. HARDWARE DEVELOPMENT OF POCKET AND HAND-HELD COMPUTERS AND ACCESSORIES

The demand for pocket computers and their 'hand-held' siblings was not large compared to laptop and desktop 'personal computers'. Because their products were sold around the world, Sharp continued to innovate to keep pace with display and circuit technology, and to explore new uses. A SHARP document in my file "New Product Introduction, September 1987" says this:

"Demand for pocket computers with extended capacity RAM cards has been steadily growing. To meet this demand, we put the PC-1280/1285 pocket computers on the market during the period ... fiscal 1986-1987... The CE-2H64M — a 64KB RAM Card — offers a considerably larger RAM capacity for the PC-1280/1285 to help meet the increasing demands for VAR (value-added resale) product applications." "Uses: As on-board memory for storage of program/data. As a program file, providing memory functions like a floppy disk."

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[3]Micros For Managers, Catalogue Summer 1982: "Welcome to the Computer Age. All of us manage time and money. To achieve what we want with limited resources is a lifetime challenge. We can achieve more if we could manage better with the resources we have. The handheld or 'pocket' computer is made for the individual. It is cheap enough to purchase from individual resources, you can take

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it anywhere, and it does not forget. It has the capacity, reliability, utility to apply to many individual tasks. It can help you manage your time and money better. It can help you achieve more."

Another interesting example is the Sharp CE-153 Software Board (1983). "This is touch keyboard containing 140 keys in a 10 x 14 key configuration. It is ordinarily used by placing a template on top of it in order to obtain the type of data designated by the template,..." It connects to the PC-1500 pocket computer with CE-150 interface by ribbon cable. The Instruction Manual gives programming instructions (extended BASIC software cassette included) together with several sample programs: **"Planetarium** - By pressing the constellation name on the software board, the shape of the constellation, as well as the month, day, time, and direction that it can be seen will be instantly printed for you. ...**Painter** - The printer (four color pens plotter) draws the outside scenery. The software board is like a canvas,... combining ten scenery elements of varying size and position, you can enjoy your favorite pictures. **Inventory Control -** Check stock at the touch of a key..." Forty years ago the touch-screen was rare, and here was a product which you could buy and program a battery powered, portable touch-screen computer system!

B. More powerful 'Hand-Held' Computers

In 1982 a larger (195 x 86 x12mm) computer PC1500 with a CMOS 8 bit processor developed by Sharp was marketed for $280. Figure 2. Around 1986, its faster successor PC–1600 also had a runtime variant PC–1605. Those machines had powerful CPUs similar to desktop personal computers with Z-80/A instruction set. But they offered portability. Larger batteries (3x or 4x AA or AAA Alkaline) increased their size and weight, so these pocket computers are sometimes referred to as 'hand-held' to distinguish them from 'pocket' and 'laptop' computers. Real-time clocks enabled them to interface and control other machinery. They were more expensive, and more advanced, with built-in forms of operating system. Figure 3.shows a timeline of early pocket computer hardware development. It was drawn in 2007 by the participants at the 'reunion' of the pocket computer development team.[E 6.] The last of the larger pocket computers PC-1600U came out around 1993, was expensive (ca $750.) and not many were sold.

C. Vertical markets and value-added resellers

The SHARP PC-1270, shown in Figure 4, is designed only for program execution; therefore it has no programming capability. The programs to be executed would be created by using other types of computers and then stored/transferred into the PC-1270. This category of "RUN only" computers were the main type sold by value-added resellers (VAR) market.

There are two rows of four function keys. Programs labeled "A","B", "C", etc. are assigned (defined) to any of them and will start when pressed. The software developer prints a template with space above each key to identify the program that will start.

Prominent YES, NO keys and numeric calculator keys give a simple uncomplicated interface to operate. Two 'pin' buttons marked IN and OUT are used to load programs/data. In order to avoid unauthorized copying, transfer of the program from these computers can be disabled. If the application needed a print-out, the

CE–125 or CE–126P were available as accessories..

"The PC-1270 really changed the primary market for the pocket computer. Previously the market was for the education/hobby user. But the run-time only device at a reasonable cost really opened up the business/commercial user market."[4]There was a big market for these machines. Resellers sold hundreds to finance companies. The PC–1270 introduced in 1986 cost $80., The PC–1285 (1986) clamshell design. Further developments in this format appeared in 1991, PC–1365, a runtime version of the PC–1360, and are listed in the APPENDIX.

By late 1990s consumer electronics development focused on mobile telephones. 'Smart' phones have microprocessors and can be programmed with applications that had been in some pocket computers. The programming effort is considerable.[5] That marked the end of the pocket computer era. Around 2000 probably the last PC-1270 was manufactured, after nearly twenty years production. Fabrication technology had advanced so much that older microprocessors and components were no longer economic to manufacture.

D. Maintenance, Servicing, and Repairs

Unlike many of today's electronics products, SHARP and CASIO were repairable, and parts could be ordered from their subsidiaries and distributors in many countries.

SHARP published Service Manuals for every calculator and computer. Everything that service technicians needed for repairs. Circuit diagrams, lists of parts with price codes. Explosion drawing of all parts in sequence of assembly.

SHARP also published Technical Reference Manuals that explained the internal structure, the functions and machine code with system calls and programming examples.

This kind of support is seldom seen in consumer electronics products today.

V. SOFTWARE DEVELOPMENT TOOLS

Developers need to write and maintain libraries of their application software in an efficient way, and software tools to manage the author- debug- modification- test procedures became available.

A: Third-Party Software Development Tools

Machine language controls the hardware directly. It is used only by the most ardent users who need to

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[4]Bill Symmes, PromSoft.com "A major point missed by SHARP (and many others) is that the PC-1270 was so successful because it was manufactured (unchanged) for such a long time (1986-1999). This allowed the development of really sophisticated software for the device -we have many man-years in some projects for the PC-1270, and we still, in 2019, sell some software for it (using used or reconditioned units)."

[5]Symmes, "The time needed to move a complex pocket computer program to an iPhone is about 4 months! It will be quite a while before we move many to the iPhone."

write custom software. Applications are normally developed using a higher level language, writing symbolic instructions of the BASIC interpreter which is embedded in Sharp pocket computers. Writing code, testing and removing errors is part of the process. Errors can be found quickly and corrected immediately on Sharp pocket computers by single keystrokes. S'BASIC allows five levels of subroutine nesting and alpha labels for calling them. A summary of the development of Sharp BASIC for different machines is shown in Figure 5.

Writing lengthy programs on a tiny keyboard is not efficient. Coding, editing, debugging on a personal computer with a full size keyboard was essential to write and maintain libraries of application software. Developers and distributors in several countries wrote software tools for this purpose.

An example is the development software product Sharp Basic Compiler (SBC) written by Bill Symmes, PROMSoft Inc., Vermont U.S.A. This software converts a standard ASCII text file into the internal object format used by the PC–1270 and PC–1250A computers. Its features enable the programmer to write and maintain programs in considerably less time and with greater accuracy. It allowed #INCLUDE files so standard subroutines and headers could be implemented. SBC compresses each line to minimum space. Large data array sizes, large program sizes could therefore fit in a single RAM card. With this software VARs and developers were able to quickly manage the writing and revision of pocket computer application software. At the same time they could deliver larger more complex programs in smaller, less expensive RAM and E-PROM memories.

B: PEOPLE - BUYERS, DEVELOPERS, HOBBY CLUBS, DISTRIBUTORS, MANUFACTURERS.

About 1980, SHARP Corporation subsidiaries in USA, UK, Australia, Germany and France looked for people to write material for their computers. Computer magazines were one source with regular contributors writing for specific machines. Many individuals were attracted to write books, translate manuals, and develop applications software. Pocket computers fostered the immediate take–up by ordinary people curious about computers, not only engineers or technical students.

An example of the high quality and breadth of interest is evident in a publication of the SHARP Users Club Magazine. [E 7.]

The Origins of PockeTax: by M.S. Shallcross Chartered Accountant. Mike is an individual who, in 1980, bought a PC-1211 pocket computer, learned to program with it, and then developed time-saving *PockeTax*. Other tax software at the time did not give a quick and accurate answer to on-the-spot tax problems. Written and supplied with the Sharp PC-1251 , from 1984 to 1991, it cost £200. which included the pocket computer.

CONCLUSION

Sharp and Casio had the main market for pocket computers worldwide. The variety of products made by Sharp Corporation required large investments and commitment of engineering, manufacturing and marketing resources. Evidence of the careful engineering, quality manufacturing and high standard of marketing can be seen in the utility and durability of their products.

The market for pocket computers was unknown. The people who explored it and developed it deserve recognition. SHARP Corporation marketed worldwide a large variety of compatible pocket computers with support for servicing and sales to consumers.

People from many professions, businesses, or unskilled, of all ages -schoolchildren to retired folks -, were able to learn to write programs that did useful tasks, gave enjoyment, and prepared them for age of the personal computer that followed.

APPENDIX: A LIST OF SOME PROGRAMMABLE POCKET COMPUTERS 1980-2000

POCKET-SIZE:

-CASIO PB-100, 1983, 116gr. 2xCR-2032 batt., 2kb, 165x71x10mm. Accessories FA-3 cassette interface only, FP-12 Printer. A Russian made clone of the PB-100 was named Angstrom.

-CASIO FX-850P, 197gr. W.2xCR2032 + 1xCR1220 lithium "coin" cells batt. Had VLSI specific CPU, 32char x 2line display, RAM card slot memory 4/12/36kb, 193x78x12mm.

-CASIO PB-700, 1984, 315gr.w.4 x AA batt.,+1 x CR1220, 20char 4lines, 160 x32 pixels.,4/8/12/16kb w. (0-3ram cards) 200x88x33mm.

-SHARP PC-1211, 1980, $200 (also sold by RadioShack as PC-1), 170gr., 4x MR-44 mercury batt.@1.35v., 1x24char yellow display 5x7matrix char.,mem.1,424steps+reserved 48steps., CPU dual 4-bit CMOS LSI, 256 kHz SHARP SC43177&8. 175x70x15mm. Operating time ~300hours at 20deg.C.

-SHARP PC-124x & PC-125x, 1982, $75-125. -115gr., 2xCR-2032 Lithium batt., 6v, 0.03watts, 1x24char LCD display (5x7matrix). 24k ROM, 2k RAM, 8bit CMOS CPU, 52 keys, 135x70x9.5mm.

-SHARP PC-1350, 1985,4 line display, Sharp designed SC61860 8-bit CMOS microprocessor ESR-H.
The Radio Shack Corp. marketed several models of Sharp pocket computers under the brand Tandy Radio Shack. Eg. TRS-1 or PC-1.

HAND-HELD: CPU clocked

-CANON X-07 1983, 630gr. Incl. 4xAAbatt., 20ch.x4lines display, 200x130x30mm

-PANASONIC RL-H1000 and 1400, 1983, 585gr. Integral NiCad batt., 26char x 1line display 159x8pixel, 227x95x31mm.

-SHARP PC-1500, 1982, $259., Sharp LH5801 8 bit parallel microprocessor, 9 bit polynomial timer, 82 instruction set, clock, 26 char x 1 line display, 2.6 MHz, 195x86x25mm

-SHARP PC-1600, 1986, $450. 26 char x 4line display, 156x32dots graphics, 3.6 MHz Sharp SC7852 cpu (Z-80A compatible), LH5803 slave cpu (PC-1500 compatible 1.3MHz), LU57813P sub-cpu 307KHz, 96k bytes ROM, 16k-80k RAM, 2x expansion slots in back. 4x AA battery 6v, 0.48w, 390g, 195x86x25.5mm

-SHARP PC-U6000, 1993, $650., 340gr inclusive 4xAAA + 1 x CR2016, 4 x 40char display 32x240 pixel, 8bit SHARP CMOS CPU, 256kb ROM, 64->544kb RAM, 220x105x19mm. Accessory CE-2501 Graphics card 42x54x3mm

-TOSHIBA Intelligent Hand Held computer "Passopia-Mini": Model IHC-8000, 1983, 365grams incl. 3xAAA batteries, 24 char. display, QWERTY and numeric keys, 195x88x25mm

SHARP **run-time-only** pocket computers, no alpha keys, not programmable. -PC-1270 manufactured (unchanged) 1986-1999?) was most successful. Others PC-1252/53 : the companion to ->PC-1250/51. PC-1285: ->PC-1280. PC-1365: ->PC-1360. PC-1605: ->PC-1600.

ENDNOTES

1. Bill Symmes, owner of PromSoft Inc. has published a table listing many of SHARP Pocket Computers and their accessories from about 1977. Included is a section on Cartridge Calculators that precede the pocket computers (July 1975). www.sharpcomputers.com
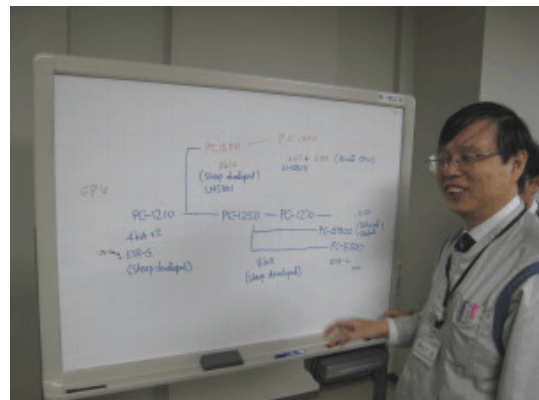
2. USA Patent number 284,474 July 1, 1986 to Mr. Masaji Sawada, claim "The ornamental design for a portable computer." The SHARP PC-5000 was self-contained, battery powered MS-DOS, with SHARP CPU - fast NMOS Intel 80-86 compatible.

3."The Mobile Micro", Which Computer? May 1984. Reprint is in Author's file.

4. An informed comparison of the PC-1211 to the Hewlett-Packard HP-41C programmable calculator was written by Valentin Albillo, "Know Thy Foe: A New Contender". It is available on-line, www.hpmuseum.org

5. Pocket Computers Save Budgets, Dawes Potter, The Mathematics Teacher, National Council of Teachers of Mathematics, Vol.77, No.7 (Oct. 1984), P.500, 502. "... We also avoid the terrible frustration suffered by many teachers: how do you introduce computers to beginning general mathematics studentsand Advanced Placement calculus students in the same class? The pocket computer approach lets the teacher develop programming skills appropriate."

6.There were two separate development groups at Sharp. Calculators - (located in Nara, Japan)- responsible for pocket computers, calculators and many interesting devices. Computers - (Osaka, Japan) - designed desktop home and office machines (in 1970-1980s: MZ-80A/B/K, MZ-700/800), portable computers (in 1982: PC-5000 portable office, was first of laptops), and the handheld computers (from 1982 onward, PC-1500/1600). On my visit to Japan in 2007, I met several members of the original computer development teams at Sharp Communication Systems facility in Higashihiroshima, Japan.

7.Sharp Users' Club, 11 Harcourt Close Henley-On-Thames, U.K. Copyright 1989. In the November 1989, Vol. 9, Nr.3 issue, the Editorial by Maurice Hawes "Next year will be our 10th - not bad for a Club devoted to a range of machines many of which are not IBM/PC compatible and only have 64K of RAM!! ... so far in 1989 we have enrolled 124 NEW members and they are still joining at the rate of 2 or 3 a week! "
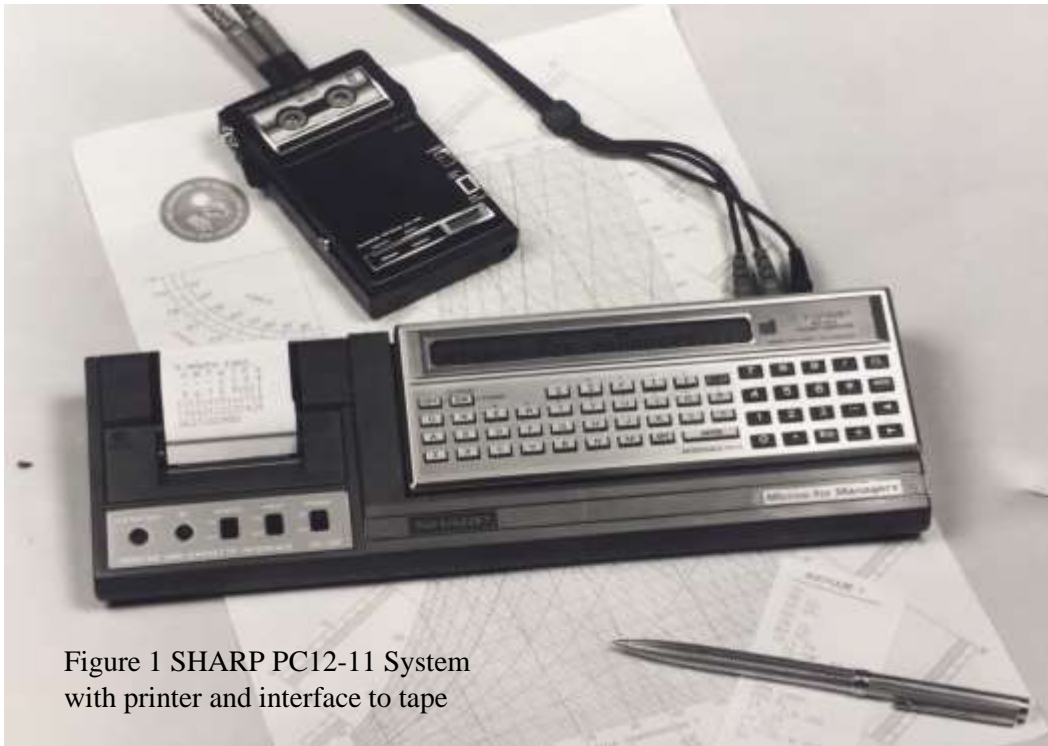
Figure 1 SHARP PC12-11 System
with printer and interface to tape

Figure 2 All have complete systems – computer, printer
and interface

PC-1211
(1980)

PC-1250
(1982)

PC-1500
(1982)

Figure 3 Timeline of SHARP pocket computer hardware development 1982-1995

Figure 4 PC-1270 Vertical applications: 8 'function' keys to start 8 programs. [YES], [NO], [Enter] keys. Programs RUN from RAM card in back

Figure 5 - SHARP structured BASIC evolved to be compatible with new hardware