IBM 5100 Portable Computer

MANAGEMENT SUMMARY

When it was originally announced in September 1975, the IBM 5100 Portable Computer was regarded as an engineering/scientific tool for solving intricate mathematical problems—but there were a lot of people who couldn't resist the urge to utilize the 5100's table-top convenience in executing business-oriented programs. Using both the APL and BASIC languages, IBM now supports four "field developed" business application packages, as well as ten other software packages that include general business analysis, mathematics, statistics, plotting, geometry, and economics. In addition, dozens of users and software houses are writing programs for applications as diverse as managing stock transactions, producing proposals, digesting survey data, controlling inventory, estimating printing costs, managing cash flow, simulating flight control, and keeping score for scouting olympics.

Also, if you are presently using data tables to look up values of elliptic integrals of the second kind, hyperbolic functions, present value factors, or chi-square values, be sure to hang onto the books they come in. In a few years, they may have some value as rare curiosities. The IBM 5100 can eliminate the necessity for having books of tables by placing a computer on your desk.

The 5100 brings together an impressive set of capabilities. Built around a one-board microprocessor, the 5100 provides up to 64K bytes of 530-nanosecond MOSFET main memory, an integral 1024-character CRT display, and an integral magnetic tape cartridge drive capable of accessing up to 204K bytes of data. The programming facility is provided by a BASIC or APL interpreter, or both, stored in read-only memory. And that's quite a lot to pack inside a case not much larger or heavier than an IBM Selectric office typewriter.

IBM's 5100 is a desktop-sized personal computer that bridges the gap between the business and scientific worlds by offering BASIC and APL software. New business application programs, in conjunction with a microprocessor-controlled CPU and a built-in CRT and cartridge tape drive, make the 5100 suitable for producing invoices, checking inventory levels, and handling other conventional accounting functions that were previously left to small business computers.

CHARACTERISTICS

MANUFACTURER: IBM Corporation, General Systems Division, 875 Johnson Ferry Road N.E., Atlanta, Georgia 30342. Telephone (404) 256-7000.

MODELS: 5100 Models A1 through A4, B1 through B4, and C1 through C4.

DATA FORMATS

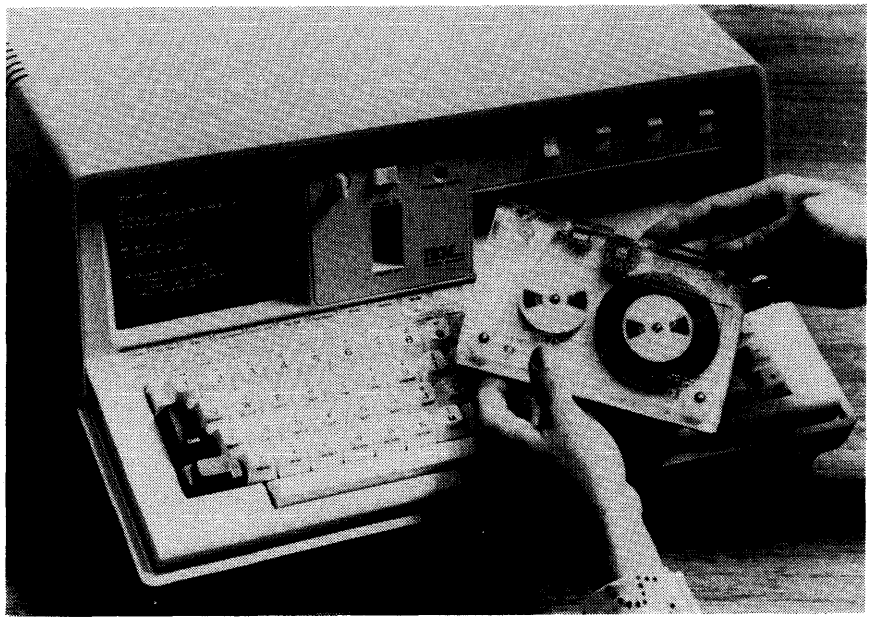
All access to the 5100 is through the BASIC or APL programming languages, implemented in read-only memory. In general, these languages provide specific facilities for numeric integers, floating-point numeric values, numeric arrays, and alphanumeric strings. Instruction formats are, in effect, the BASIC or APL statements themselves. Apparently, the internal structure is based on a 16-bit word.

MAIN STORAGE

Type: MOSFET (Metal-Oxide Semiconductor Field Effect Transistor).

CYCLE TIME: 530 nanoseconds per two-byte access.

CAPACITY: 16,384, 32,768, 49,152, or 65,536 bytes.



The 3M-style magnetic tape cartridge is featured in this photo of a basic 5100. The cartridge can store up to 204,000 bytes of data or programs. The built-in CRT can display up to 1024 characters; the characters are rather small, but legible at normal working distances. This 5100 is one of the C series models, which give users a choice between the BASIC and APL programming languages.

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An 80-cps or 120-cps serial printer and a second magnetic tape cartridge drive can be added, and an optional communications adapter makes the 5100 look like an IBM 2741 typewriter terminal to a remote host computer. With the addition of a Serial I/O Adapter, plotters from various manufacturers can be attached to a 5100; but no disk or diskette storage is available for the 5100 at this writing.

Details of the internal organization of the microprocessor have not been released to date, but the 530-nanosecond memory cycle time mentioned above is based on a two-byte fetch, providing at least the potential for impressive computational speeds.

Supporting the system are four application libraries; one for business functions, one for scientific/engineering computations, one for printing and plotting, and one for statistical functions. These capabilities are supplemented by the mathematical functions built into the BASIC and APL programming languages. Thus, the basic tools for numerical computation are provided. But procedures peculiar to specific disciplines will generally have to be programmed by the user through the facilities of BASIC or APL. In addition to the libraries, IBM currently supports a variety of programs that were designed for small dental offices, travel agencies, mortgage companies, and other businesses.

The businessman, in planning or evaluating situations, often has the need to handle large numbers of computations to compare costs and expected revenues or make projections. The results of these calculations often fill sizeable worksheets and require substantial time. As a result, the number of alternatives investigated may be few, to prevent the cost of the planning from exceeding the cost of the project. The presence of a small computer such as the 5100, with a sizeable internal memory and external storage, can permit many more alternatives to be looked at economically.

Also on the business application side, BASIC and APL programmers are taking advantage of the 5100's up to 64K bytes of memory and magnetic tape storage to develop common business-oriented packages that include invoicing, inventory control, general ledger, payroll, and other accounting functions where the size and the speed of the 5100 may just match a user's needs.

We have just touched the surface of the possibilities present in most offices, regardless of type, for using an in-house computing facility such as the 5100. The payoff for personnel presently using manual methods, even with electronic calculators, can be seen and evaluated, based on the amount of time currently spent on such calculations and on the value of extending the range of computations that can be performed.

It has been just a few years since the introduction of the electronic calculator. At that time, $400 for a Hewlett-Packard HP-35 pocket model or a couple of thousand dollars for a desk-top programmable model seemed a lot of money for a "convenience" item. But these units pro-

CHECKING: A parity bit is associated with each byte.

RESERVED STORAGE: A total of 4,400 bytes of main memory is reserved for the BASIC interpreter in addition to the read-only memory; for APL, a total of 6,700 bytes is reserved.

CENTRAL PROCESSOR

GENERAL: The three general 5100 models A, B, and C, are distinguished by whether the APL interpreter (A series), BASIC interpreter (B series), or both (C series) are implemented. Switching between the two languages is accomplished in the C series models through a front panel switch. Within each series, there are four models corresponding to main memory sizes of 16K, 32K, 48K, and 64K bytes.

The internal structure of the 5100 has not been detailed publicly as yet. It is based on a single-card microprocessor. The basic memory speed is quite fast. This may be compromised by the internal organization of registers and I/O arrangements, but no definite comment can be made at this time.

The instruction repertoire is effectively that of the BASIC and/or APL languages. These high-level languages permit symbolic addressing of data values, loop control, and program flow structuring, along with procedure-oriented facilities for numeric computations. Alphanumeric strings can be handled for display or printing of table heads, interactive prompting, error or condition displays, etc.

Each 5100 computer includes a 1024-character display, a cartridge tape drive, and a keyboard. The keyboard keytops are engraved with symbols corresponding to the elements of the language implemented in each model. For BASIC models, most of the language statement keywords can be centered with a single key depression in conjunction with the Command key. Also on BASIC models, the accompanying 10-key numeric keypad can be used as function keys, with the meanings defined by user programming. On both BASIC and APL models, the top row of keys carries alternate usages for various system and peripheral functions.

The BASIC and APL interpreters are implemented in read-only memory, or, as IBM refers to it, read-only storage (ROS). ROS is implemented in MOSFET technology with 48K-bit chips. Also included in ROS are system control functions and I/O drivers.

PHYSICAL SPECIFICATIONS: The 5100 computer occupies a space 8 by 17.5 by 24 inches; it weighs between 46 and 50 pounds depending on memory options. The basic package includes the CRT and built-in tape cartridge drive. It operates on conventional 115-volt, grounded AC power. The optional tape cartridge unit measures 7.25 by 10 by 12 inches and weighs 18 pounds. The optional printer weighs 56 pounds and measures 12.25 by 13.25 by 23 inches. Separate power outlets are required for the optional printer and cartridge drive.

INPUT/OUTPUT CONTROL

The processor provides one I/O port for attaching one external cartridge tape drive and one printer. A separate facility is provided for connecting the communications option. However, when the 5100 is used as a communications terminal, user programs cannot be entered. If both the external cartridge drive and the printer are included, the printer is attached to the cartridge drive, which is then attached to the processor. This represents the data flow path; each of the units has to be plugged into a wall outlet. One External I/O Adapter is a prerequisite for attachment of any external peripheral combination.

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PERIPHERALS

MODEL	DESCRIPTION & SPEED
INTEGRAL WITH PROCESSOR	
CRT/Keyboard	1024 characters; 16 lines of 64 characters; black on white or reverse, switch selected; spread-out of left or right 32-char. line half, switch selected; data entered on bottom line with automatic upward scrolling.
Magnetic Tape Cartridge Drive	Uses 3M-style tape cartridge containing 300 feet of 0.25-inch tape; data recorded in 512-char. physical blocks with logical records separated by record marks, program interpreted; 40 inches/sec; 2850 char./sec read, 950 char./sec effective write including write with backspace and read/check
MAGNETIC TAPE	
5106	Auxiliary Tape Unit; same specifications as integral unit above
PRINTERS	
5103-1	Serial, bi-directional, 132 positions, 10 char./inch, 6 lines/inch, full APL/BASIC char. set, up to 6-part forms, 80 char./sec.
5103-2	Serial, bi-directional, 132 positions, 10 char./inch, 6 lines/inch, full APL/BASIC char. set, up to 6-part forms, 120 char./sec.
OTHER DEVICES	
6103	Serial I/O Adapter; RS-232 compatible, 20 to 9600 bps
TV Monitor	Multiple CRT monitors can be connected serially; contact IBM for configurational possibilities and prices

vided more than just convenience. They allowed personnel relatively unskilled in high-speed arithmetic calculations to equal the productivity of specialists. They eliminated the need for laborious recalculations because of simple arithmetic errors.

The 5100 can do the same things at a higher level. It can permit increased productivity without the need for highly skilled specialists, who are in increasingly short supply. Computational specialists may not even know the theory behind the computations they perform. They can simply execute the procedures required for specific tasks, as outlined by a person conversant with the theory. This does not eliminate the specialists, however, because they now have a more powerful tool with which to exercise their skills.

Introducing new personnel to numerical analysis through a personal computer does bring about a problem in interpreting the results of computations. The computer will cheerfully display the results to whatever degree of precision (number of decimal places) it is programmed to produce. The *accuracy* of the result, however, does not necessarily agree with the *precision* of the result. The cause may lie in imprecise input, in the computational algorithm, in using the computational algorithm outside the range for which it was designed, or in internal round-off and truncation. In purchased algorithms, such as those in the IBM program libraries, normal practice includes identifying the applicable range of each procedure in the supporting documentation accompanying it. This can sometimes be overlooked. But the real problem is with user-generated procedures. Calculation of the applicable range for a given error level is a taxing mathe-

The Serial I/O Adapter feature permits connecting a wide range of peripheral devices available from sources other than IBM. Usefulness of the feature is somewhat limited by a maximum data transfer rate of 9600 bps. Otherwise, it is quite flexible. Permissible data codes include 5-level Baudot, 6-bit-plus-parity BCD, 7-bit-plus-parity ASCII, 7-bit ASCII without parity, and 8-bit ASCII without parity. Device control is exercised through the APL or BASIC language; no specific devices are supported. The adapter requires the 1524 Expansion Feature, and is available under the Pilot Test Plan.

MASS STORAGE

To date, IBM has not announced a true mass storage device for the 5100. The integral and/or external cartridge tape units can be used to store data and programs. The maximum capacity of a tape cartridge is 204K bytes. Data and programs can be indexed for direct retrieval, but the method of access is necessarily sequential rather than random.

INPUT/OUTPUT UNITS

See Peripherals table.

COMMUNICATIONS CONTROL

The Communications Adapter permits the 5100 Computer to communicate with a remote IBM or other computer; the 5100 appears as an IBM 2741 typewriter terminal. Half-duplex, asynchronous transmission at 134.5 or 300 bits per second is supported via a user-supplied modem with an RS-232C interface, such as the Bell System 103. Transmission over a leased line or the public telephone network is possible. Only the EBCDIC transmission code is supported. While in the communications mode, the keyboard and display of the 5100 logically correspond to the keyboard and printer of a 2741. Received data can be simultaneously printed if the optional printer is included. Alternatively, the magnetic tape cartridge can serve as the origin and/or destination of data.

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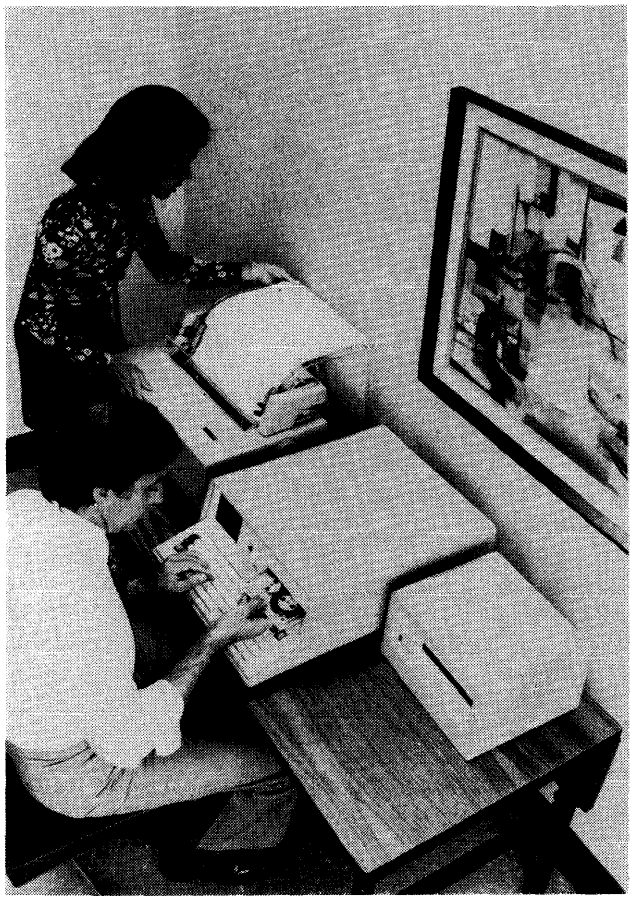

Pictured here is a full-blown 5100 with the optional 80-cps printer and second magnetic tape cartridge unit.

matical procedure that is often ignored because of the time it adds to the programming task. Widespread use of desk-top computers such as the IBM 5100 may well lead to increased interest in providing the user with improved methods of estimating error ranges for his programmed procedures. In any case, prospective users should be made aware of the old precision/accuracy problem, which has been faced by data processing personnel since the early days of computers, but which may be entirely new to people just acquiring a desk-top computer.

The concept of a desk-top calculator/computer that can be programmed in a higher-level language is not new. Both Hewlett-Packard and Wang Laboratories have marketed such units for several years, and in the same general price range as the IBM 5100 for equivalent configurations. However, the 5100 is distinguished by the capacity of its main memory and in the provision of two programming languages.

Memory sizes range from 16K bytes to 64K bytes in 16K-byte increments. For each memory size, there is a corresponding 5100 model for the BASIC language, for the APL language, and for a combination of BASIC and APL. Switching between the languages in the combined models is accomplished through a front panel switch. User programs cannot be entered or executed while the 5100 is in the communications mode. The Expansion Feature is a prerequisite for the Communications Adapter. The 5100, operating as an IBM 2741 terminal, is supported by all IBM System/370 configurations that include an Integrated Communications Adapter or a 3704/3705 Communications Controller through standard teleprocessing access methods such as BTAM, TCAM, and VTAM.

SOFTWARE

OPERATING SYSTEM: The system control functions are integrated into the ROS module, with some main memory space required for symbol tables, etc. System control functions are primarily concerned with coordinating the interface between the user programs and the language interpreters and peripheral devices.

In effect, there are three modes of usage: program development, interactive program writing with execution, and interactive execution of a previously written and stored program. Depending on the computer model, the programming language may be BASIC, APL, or either of the two. IBM presently offers four application program libraries for business, scientific/engineering, statistical problems, and plotting.

PROGRAMMING LANGUAGES: *BASIC*, for the 5100 B and C series models, is implemented at a level similar to IBM VS/BASIC for the System/370. It supports stream data files and matrix (two-dimension array) operations. Independent output to the printer of data displayed on the built-in CRT is supported. BASIC includes capabilities for manipulating alphanumeric strings. The statements use English-like forms, so BASIC is the logical choice for first-time users. In addition to ROS, the BASIC interpreter occupies 4,400 bytes of main memory, which is not available to the user. A prerecorded data cartridge containing an instruction program for the BASIC language is available optionally.

APL, for the 5100 A and C series models, is implemented at a level similar to IBM APLSV. It supports data files on magnetic tape and arrays of up to 63 dimensions, as well as comprehensive mathematical, logical, and relational operators and functions. Independent output to the printer of data displayed on the built-in CRT is also supported. APL is the logical choice if complex mathematical or logical operations are required.

APPLICATION PROGRAMS: IBM currently supports four "Libraries": Business Analysis, MATH, Statistics, and Print Plot. The Business Analysis library is available only for BASIC machines, while the other three are available in both BASIC and APL versions. In addition, four accounting packages and three specialized packages are available from IBM. Each of the application programs is supplied on magnetic tape cartridges and comes with a user's guide.

The *Business Analysis/Problem Solver Library* includes 30 BASIC routines specifically oriented to problems in spread sheet, investment, depreciation, break-even, and time series analysis. The spread sheet analysis is a general report preparation tool that permits tabular presentation of data with line arithmetic (e.g., multiply line 2 by line 3) and cumulative column presentations. Data values can be input from the keyboard or from a previously recorded magnetic tape cartridge file. Some routines include the capacity to insert your own algorithm if the standard facilities provided do not include the operation you need. The investment analysis series of programs permits computation of return on investment, discounted cash flow analysis, multiple and single loan analysis, lease versus purchase analysis, and make versus buy analysis. Included in the depreciation analysis series of programs are straight line, sum-of-years digits, declining balance, and equipment units methods. The break-even or cost/volume profit analysis series permits computation with

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The BASIC language is widely known and used. Its English-like statement keyword structure makes it an easy language to learn and a logical choice for first-time users. BASIC also provides convenient facilities to handle alphanumeric strings for annotating tables, and for writing business-oriented programs. The APL language is more suited to expressing complex mathematical relationships.

The 5100 is also novel in the way IBM is supporting it. The support is similar to that provided for the company's typewriters. No customer engineer shows up when you install the 5100. You read the instruction book that comes with it and set it up yourself.

When initially released, the IBM 5100 was a purchase-only item. In December 1975, three months after its introduction, a Purchase Pilot Test Plan was announced to make the 5100 available to more users. Maintenance agreements are available, naturally, just as with typewriters. IBM has set up a separate staff to handle the 5100 within the General Services Division.

USER REACTION

Summarized below are the results of Datapro's interviews with 10 IBM 5100 users. Our sample consisted mostly of business-oriented users employing the 5100 in typical accounting functions such as payroll, inventory control, general ledger, invoicing, accounts receivable, etc. There were also two not-so-typical users in our survey. One shipping company was using three 5100's on board some of its tankers to prepare the seamen's payroll and to help the captain calculate the stress and draft due to various loadings of the tanker. A representative of this company mentioned that the power supply on-board the tankers fluctuated, but the 5100 didn't seem to be affected. Another user was a meat wholesaler who was using the 5100 to calculate the optimum price for his products due to fluctuations in the market as well as fluctuations in his inventory and the age of the meat.

The typical system included 32K bytes of memory, two magnetic tape drives, and one printer. The average system had been installed for nine months, and our sample was evenly split between users of the BASIC and APL interpreters. With regard to the sources of software, four users wrote their own, three relied on outside software houses, one used IBM's software exclusively, one used a combination of outside and in-house software, and one used a combination of IBM and in-house software.

Here's how these 10 users rated the 5100 and the associated IBM support:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	8	2	0	0	3.8
Reliability of mainframe	6	3	0	0	3.7
Reliability of peripherals	4	2	1	1	3.1
Maintenance service:					
Responsiveness	5	5	0	0	3.5
Effectiveness	4	5	1	0	3.3

definite probablistic assumptions. The time series analysis group of programs provides a wide range of computational capabilities for time-oriented data for compound growth rate projection, moving average, and seasonal or cyclical analysis, as well as for simple statistical problems such as auto or cross covariance and correlation, exponential smoothing, and simple regression.

Generalized routines also provided in this library permit a user to construct and display histograms, create and update user files, resequence or rearrange records in files, and print data files. The Business Analysis Library requires a 5100 Model B2 or C2. The optional printer is recommended for the spread sheet analysis program group.

The *Math/Problem Solver Library* includes a comprehensive set of numerical analysis routines. There are 37 programs in the APL library and 44 programs in the BASIC library, but essentially the same capabilities are provided with each library. The facilities provided can be broadly grouped into calculus, including integration, differentiation, and solution of ordinary differential equations; linear equations and matrix analysis, including eigenproblems, least squares solutions, linear programming, and solution of linear equations; approximations to functions and zeroes of functions, including several interpolation and approximation methods, function smoothing, minimums and maximums of tabulated functions, etc.; and evaluations of advanced mathematical functions such as the Gamma function, Bessel and modified Bessel functions, elliptic integrals and functions, orthogonal polynomials, etc. The complete MATH library can be run on a 5100 A2 (APL), B2 (BASIC), or C2 configuration. A majority of the routines in the BASIC library can be run on a 5100 B1.

The *STAT/Problem Solver Library* includes 40 (APL) or 41 (BASIC) routines for the analysis of numerical data through commonly used statistical techniques. The routines can be broadly grouped into elementary statistics, including histogram, cross-tabulation, moment, tally, and Chi-square and T test; regression and correlation analysis, including simple, stepwise, multiple, and polynomial regression; multivariate analysis, including discriminant analysis, canonical correlation, and factor analysis; analysis of variance; time series analysis, including moving average, seasonal and cyclical analysis, auto and cross covariance and correlation, and triple exponential smoothing; nonparametric statistics; and biostatistics, including survival rate and profit analysis. Four routines in the library provide capabilities to enter and display/print, correct, modify, generate, or smooth data. The BASIC library can be run on a 5100 B1 or C1; the APL library requires a 5100 A2 or C2.

The *Print Plot/Problem Solver Library* includes a series of modules that provide a wide range of plotting capabilities and can utilize data received from a BASIC program, from an APL program, or directly from a keyboard. With the addition of a 6301 Serial I/O Adapter, the 5100 can utilize an absolute vector plotter or a storage display terminal. The program provides the capability for generating line graphs, bar charts, histograms, point plotting, and others. The user specifies metric or inch plotting, the size and location of the graph within the plot limits, the location of the origin within the graph, the X and Y values at the origin, horizontal and vertical scaling factors (either linear or logarithmic), automatic axes, automatic grids, horizontal and vertical dot density, special symbols, and any data files that are used in conjunction with program-generated and keyboard data. The platen is reversible so that the paper can be moved backward as well as forward. The BASIC version requires at least a B2 or C2 model of the 5100, while the APL version requires at least an A2 or C2 model.

The *Dental Office Management System* was designed by a practicing dentist to avoid an increase in personnel due to in-

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	Excellent	Good	Fair	Poor	WA
Technical support	3	3	3	1	2.8
Manufacturer's software:					
Compilers and assemblers	1	4	0	0	3.2
Application programs	3	2	1	1	3.0
Ease of programming	3	3	0	0	3.5
Ease of conversion	1	2	0	0	3.3
Overall satisfaction	6	4	0	0	3.6

*Weighted Average on a scale of 4.0 for Excellent.

The users in our survey generally responded favorably to the IBM 5100, as the ratings indicate. There were, however, a few exceptions. Several users said that the technical support was less than they expected, and they felt that the system was a "do it yourself" project. One user commented that he thought the manuals were hard to understand. Another user said that he had intermittent problems for about a month, before someone told him about the desirability of having the 5100 on its own separate power line. In the area of peripherals, the only negative reactions we received were directed toward the magnetic tape drives.

The principal strengths that were identified by these IBM 5100 users included the ease of programming, the ease of operation, the surprising power for such a small system, the APL language, and the professional appearance of the printed output when a carbon ribbon is used on the serial printer. One user said that the equipment was capable of much more than IBM told him. Another went as far as to say, "Any idiot can learn to use one," while still another user said, "It does things the way we want them done."

With powerful computers being steadily reduced in size due to the achievements in the microprocessor and memory industries, table-top computers will be getting progressively more popular among engineers, scientists, businessmen, students, and hobbyists. We can expect to see many more models of this type being announced by various vendors during the next few years. The presence of current models such as IBM's 5100 will certainly influence the design, pricing, and support of these future models.□

creased paperwork. This comprehensive system prints out a list of the dentist's scheduled patients along with the patients' account balances, produces insurance forms while the patient is present, separates patient charges from insurance charges, maintains a payment record for each third party, produces aged trail balances for both patients and third parties, calculates patient budget plans, and prints recall notices when scheduled. The system is capable of handling up to 30 patients per day, and produces a financial activity summary at the end of each day. The minimum configuration that will support the system consists of a B4 or C4 processor (64K), one 5106 auxiliary tape unit, and one 5103-1 printer. The programs are written in the BASIC language.

Computing for an Accounting Practice: Client Accounting, Time Management was written by a small CPA firm to provide write-up services for clients, as well as to provide a tool to manage the firm's practice. Besides write-up work, the system produces balance sheets and income statements with supporting schedules, statements of changes in financial position, trial balances, general ledgers, client billing worksheets, and employee productivity summaries. The minimum configuration that will support the system consists of a B2 processor (32K), a 3601 external I/O adapter, and a 5103 printer. The Programs are written in the BASIC language.

The *Travel Agency Accounting System* was designed to manage the cash flow of funds within a travel agency. The major areas handled by the system include sales and refunds, profit and loss statements, balance sheet accounting, journal entries, bank balance records, disbursement journal accounting, commercial invoicing, weekly ATC reporting, employee productivity, employee payroll, and airline ticket and itinerary writing. Month-end reports include a sales journal of receipts and invoices, a refund journal, a disbursements journal, an open transactions journal, a cash receipts report, and an accounts receivable journal for the agency's commercial accounts. The system can handle from one to six offices, up to 50 employees in all offices combined, up to 50 commercial accounts per office, and up to 250 cash and 150 credit card sales per office per week. The minimum configuration that will support the system consists of a B2 processor (32K), a 3601 external I/O adapter, a 5103 printer, and a 5106 auxiliary tape unit. The programs are written in the BASIC language.

The *Mortgage Closing and Property Settlement System* prepares the documents commonly required by mortgage lenders, title companies, and settlement attorneys for the transfer and settlement of real property. Automatic calculations include principal and interest payment, maturity date of a loan, annual percentage rate, mortgage insurance premium, daily interest, state and local transfer tax, escrow reserves, and recordation fee. The system produces a host of forms that include customized HUD settlement statements, federal truth in lending forms, instruction letters, and closing settlement documents. The system can handle up to 300 active cases or loans in the minimum configuration, depending on certain variables. The minimum configuration that will support the system consists of an A2 processor (32K), a 3601 external I/O adapter, and a 5103 printer. The throughput can be increased by using a processor with a larger memory capacity. The programs are written in APL.

APL GRAPHPAK is a set of APL functions which provide interactive graphics support for devices which attach to the Serial I/O Adapter (6301) on a 5100 processor. A total of 62 functions provide capabilities ranging from fundamental graphic support through high-level graphics applications. The functions are grouped into the following component workspaces: fundamental graphic support, curve plotting, curve fitting, contour plotting, descriptive geometry, and auxiliary labeling. The system supports absolute vector plotter controllers with BCD vector encoding (Gould Brush 511, HP 7202A, HP 7203), microprocessor-controlled incremental plotters (Houston Instrument PTC-5/DP-1, Tektronix 4662, Zeta Research 230), and absolute vector storage display terminals (Tektronix 4013, Tektronix 4015, Tektronix 40XX). The selection of a graphic device is the sole responsibility of the user. The minimum configuration that will support the system consists of an A2 or C2 (32K) processor (an A3 or C3 is recommended), a 6301 serial I/O adapter, and a plotter.

The *APL Coordinate Geometry System (COGO)* is designed to solve civil engineering geometry problems that involve right-of-way, highway, bridge, and interchange design, construction layouts, and general land surveys. COGO is composed of 65 functions organized into 11 groups. These functions provide for points, lines, circular arcs, transitional spirals, areas, and parabolic curves. The results are shown on the IBM 5100 display screen. If a 5103 printer is attached to the processor, input data, calculated results, and plots can be printed. COGO calculations can also be displayed or plotted by using the GRAPHPAK package. The minimum configu-

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ration that will support the system consists of an A2 or C2 processor (32K) and a 5103 printer (if printed output is desired). If a printer is used, a 3601 external I/O adapter is required.

The *APL Econometric Planning Language* is an interactive program that works with economic variables and provides for data analysis and transformation, tabular and graphic display, parameter estimation, model solution, and file handling. Examples of the use of the system include estimating advertising effectiveness, analysis and estimation of potential demand, financial planning, projection of economic indicators, and the study of economic theories. The minimum configuration that will support the system consists of an A4 or C4 processor (64K) and a 5103 printer.

PRICING

POLICY: The 5100 Portable Computer was initially available only on a purchase basis (although an installment purchase arrangement could be made). However, three months after the 5100's introduction, a Purchase Pilot Test Plan was announced. A separate maintenance contract is available. No installation assistance is provided with this product; the customer sets up the system from step-by-step instructions packaged with the unit. The warranty period extends from the date of shipment from the plant for a total of 10 days plus 3 months.

The Purchase Pilot Test Plan provides a Contract Period of three months' use for about 15 percent of the purchase price. This price includes maintenance, and is payable in three equal monthly installments. The plan applies to all models and processor options of the 5100 and to the 5103 Printers and 5106 Auxiliary Tape Unit as well. One additional period of three months can be contracted for. Conversion to purchase can be made at any time, with credit for up to 70 percent of the Test Plan payments. In effect, a three-month trial would raise the price of the 5100 hardware by 4.5 percent. A two-period (six-month) trial would up the hardware price by 9 percent. Purchase prices of the 5100 are protected during the contract period. Obviously, this plan is designed to stir interest in prospective users who are unable to see an immediate pay-off for the 5100 in their operations and are unwilling to risk the full purchase price on a "maybe" basis.

A separately priced set of magnetic tape cartridges furnishes instructions in the BASIC ($225) or APL ($295) programming language. Two source-code data cartridges and a user's guide accompany each program library and include instructional material. The program libraries are furnished for a one-time license fee. The user is expected to maintain duplicate, back-up copies of the data cartridges.

The standard 10 percent educational discount applies to the basic computer and peripherals.

EQUIPMENT: The following prices include all attachment features required, but do not include any program libraries.

MINIMUM BASIC SYSTEM: Consists of BASIC 5100 Model B1, which includes integral CRT display, magnetic tape cartridge, and 16,384 bytes of main storage. About 12,000 bytes of main storage is available to the user. The only programs available that can be run on this configuration are STAT and portions of MATH. The BASIC interpreter is included. The purchase price of this system is $8,975, and the monthly maintenance cost is $65.

MINIMUM BUSINESS-ORIENTED SYSTEM: Consists of BASIC 5100 Model B2, which includes integral CRT display, magnetic tape cartridge, and 32,768 bytes of main memory, plus the optional 5103-1 printer. About 28,400 bytes of main memory is available to the user. The Business program library, the MATH library, the STAT library, and the Print Plot library can be run on this configuration. The BASIC interpreter is included. The purchase price is $14,700, and the monthly maintenance cost is $104.

LARGE SCIENTIFIC SYSTEM: Consists of APL 5100 Model A4, which includes integral CRT display, magnetic tape cartridge, and 65,536 bytes of main memory, plus the 5103-1 printer and 5106 auxiliary tape unit. About 58,800 bytes of main memory is available to the user. The MATH, Print Plot, and STAT program libraries can be run. The APL interpreter is included. The purchase price is $21,230, and the monthly maintenance cost is $119.■

EQUIPMENT PRICES

		Purchase	Monthly Maint.	3-Month Contract Period Charge
PROCESSORS AND MAIN MEMORY				
5100	Portable Computer; includes 1024-character display, magnetic tape cartridge drive, ROS for language processor, and main memory as detailed below:			
	APL Language Interpreter—			
A1	With 16,384 bytes of main memory	$ 9,975	$65	$1,500
A2	With 32,768 bytes of main memory	11,725	70	1,950
A3	With 49,152 bytes of main memory	13,475	75	2,400
A4	With 65,536 bytes of main memory	15,255	80	2,850
	BASIC Language Interpreter—			
B1	With 16,384 bytes of main memory	8,975	55	1,350
B2	With 32,768 bytes of main memory	10,725	60	1,800
B3	With 49,152 bytes of main memory	12,455	65	2,250
B4	With 65,536 bytes of main memory	14,225	70	2,700
	APL and BASIC Language Interpreters—			
C1	With 16,384 bytes of main memory	10,975	70	1,650
C2	With 32,768 bytes of main memory	12,725	75	2,100
C3	With 49,152 bytes of main memory	14,475	80	2,550
C4	With 65,536 bytes of main memory	16,225	85	3,000
PROCESSOR UPGRADE OPTIONS				
—	A1 to A4	5,250	—	—
—	A1 to C1	1,000	—	—
—	A1 to C4	6,250	—	—

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IBM 5100 Portable Computer

		Purchase	Monthly Maint.	3-Month Contract Period Charge
PROCESSOR UPGRADE OPTIONS (Continued)				
—	B1 to B4	5,250	—	—
—	B1 to C1	2,000	—	—
—	B1 to C4	7,250	—	—
—	C1 to C4	5,250	—	—
—	C2 to C4	3,500	—	—
—	C3 to C4	1,750	—	—
OPTIONS				
1524	Expansion Feature; required for Communications Adapter	300	6	45
1525	Communications Adapter	600	10	90
3601	External I/O Adapter; required for 5103 Printer or 5106 Auxiliary Tape Unit	300	6	45
6301	Serial I/O Adapter, 20 to 9600 bps	700	15	105
1501	Carrying Case, soft	125	—	—
MAGNETIC TAPE DRIVES				
5106	Auxiliary Tape Unit	2,300	10	555
	Tape Cartridges, per package of five	100	—	—
PRINTERS				
5103-1	Printer, 80 cps	3,675	29	555
5103-2	Printer, 120 cps	4,175	35	627
—	Upgrade option, from 80 to 120 cps	1,000	—	—

SOFTWARE PRICES

	UTILITY PROGRAMS	License Fee
5721	Problem Solver Libraries—	
-XM3	Business Analysis, BASIC	$500.00
	User's Guide	19.00
-XM1	MATH, BASIC	500.00
	User's Guide	23.00
-XM2	MATH, APL	500.00
	User's Guide	17.50
-XA1	STAT, BASIC	500.00
	User's Guide	22.50
-XA2	STAT, APL	500.00
	User's Guide	22.50
-DC1	Print Plot, BASIC	500.00
-DC2	Print Plot, APL	500.00
5798-NFX	APL GRAPHPAK	400.00

	ACCOUNTING PROGRAMS	Monthly Charge*
5796-NJC	Dental Office Management System	$150
-NJD	Computing for an Accounting Practice	120
-NKA	Travel Agency Accounting System	200
-NKB	Mortgage Closing and Property Settlement	80
5798-NGA	APL Coordinate Geometry System	176
-NHY	APL Econometric Planning Language	280

*Applies for 12 months only.

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