

IBM 1130

MANAGEMENT SUMMARY

At the time of its announcement in February 1965, the 1130 was the lowest-priced stored-program computer ever produced by IBM. That fact alone probably would have been enough to ensure its rapid acceptance. But the 1130 proved to be a truly effective low-cost computing system, not only in the scientific and engineering applications for which it was designed, but also in many small-scale business data processing applications. Deliveries of the 1130 began in November 1965, and well over 4000 systems have been installed to date.

The 1130 is primarily oriented toward "open shop" scientific installations, in which the people with the problems to be solved learn to program and operate the computer. This type of operation, while attractive in concept, leads to intolerably low operating efficiencies when applied to large, expensive computer systems. But the 1130, with monthly system rentals as low as \$694, is economical enough to make the open shop concept truly practical.

The 1130 has also been widely used for business data processing, mainly "because it was there." The 1130's fixed word-length (16 bits) and binary arithmetic mode make it a rather unlikely choice for most commercial applications. But the system's low price-tag led IBM salesmen to propose its use in hundreds of situations where the customer needed a low-volume business data processor and the price of a System/360 Model 20 was

Introduced in 1965, the IBM 1130 is by far the most widely used small scientific computer. It has also found acceptance as a business data processor despite its fixed word-length, binary arithmetic, and other limitations. The 1130 now offers a wide choice of peripheral equipment, programming languages, and application programs.

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, 112 East Post Road, White Plains, New York, 10601.

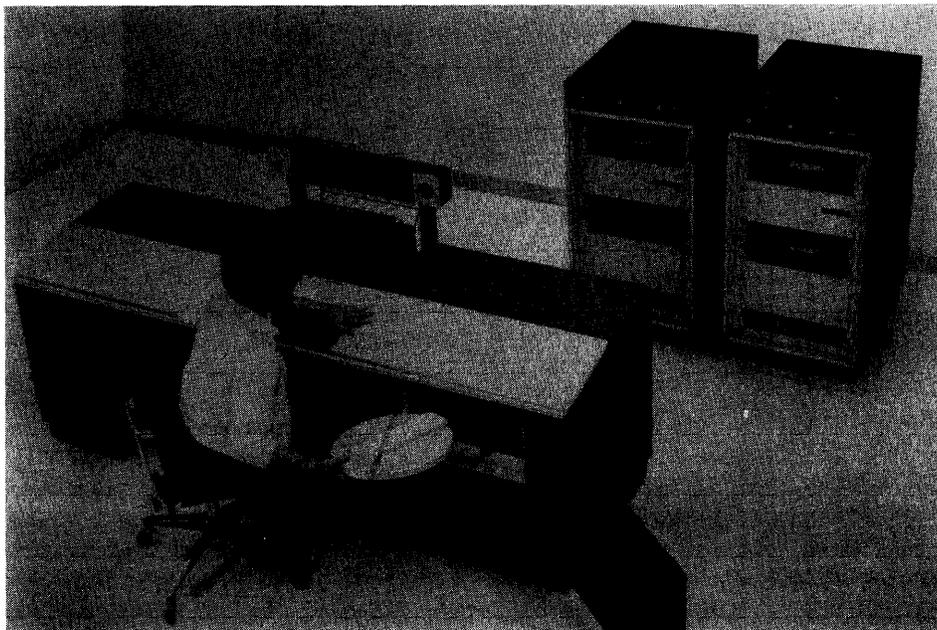
MODEL: IBM 1130 Computing System.

DATA FORMATS

BASIC UNIT: 16-bit word. Each word location in core storage consists of 16 data bits and 2 parity bits, and can hold two 8-bit bytes, one single-precision operand, or half of a double-precision operand.

FIXED-POINT OPERANDS: One or two 16-bit words, with sign in leftmost bit position. Negative numbers are expressed in two's complement form.

FLOATING-POINT OPERANDS: No hardware facilities; floating-point arithmetic is handled by subroutines, using the following formats. Each "standard-precision" operand is represented by 2 words, which hold a fraction of 23 bits plus sign and an 8-bit characteristic formed by adding



This IBM 1130 system is equipped with the maximum complement of five single-disk storage drives: the integrated drive in the 1131 Central Processing Unit and two dual-drive 2310 Disk Storage Units.

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➤ clearly beyond reach. It has been reliably estimated that about 20 percent of the installed 1130 systems are being used exclusively for business data processing.

But the July 1969 introduction of the IBM System/3 changed all that. The System/3, with monthly rentals starting below \$1,000 and a strong orientation toward business data processing, represents a far more suitable choice for most commercial applications.

For scientific computing and other "problem-solving" applications, the choice between the 1130 and the System/3 is less clear-cut. The System/3 Model 6, announced in October 1970, has many of the same desirable traits as the 1130: low cost, compact size, disk-oriented software, and straightforward operation. In addition, the System/3 Model 6 offers larger disk storage capacities, faster disk access times, a low-cost CRT display, and a conversational compiler for the popular BASIC language. But the 1130 has some significant advantages of its own: larger core storage capacity, higher I/O speeds, wider choice of peripheral equipment, standard 80-column cards, FORTRAN and COBOL compilers, and a sizeable program library. What's more, most of the 1130 software is available at no extra charge, whereas separate software pricing is the rule for the newer System/3.

Thus, it is clear that the 1130 has by no means been obsoleted by the System/3. The availability of both these systems makes IBM stronger than ever in the small-scale scientific computer market, which the company has dominated since it introduced the IBM 1620 more than a decade ago. (The 1620, a variable-word-length decimal computer that rented for roughly \$1,600 to \$3,000 per month, was superseded by the much faster, lower-priced 1130.)

Dozens of minicomputer manufacturers currently have designs on this important segment of the computer market, and their products typically offer far more central processing power per dollar than the 1130. As a result, minicomputers have displaced the 1130 in many specialized applications of a real-time or dedicated nature. But for more generalized, problem-solving applications, none of the minicomputer makers can yet match the 1130's large complements of peripheral equipment and software, nor the widespread availability and proven quality of IBM's technical and maintenance support. IBM now has a minicomputer of its own—but the fast, low-priced System/7 is being sold and supported only for monitoring and control applications, where it will not affect the continued marketability of the 1130.

As originally announced, the 1130 system had very limited expansion capabilities. Only 4,096 or 8,192 sixteen-bit words of 3.6-microsecond core storage were available, and only one 512,000-word disk drive (an integral part of the central processor cabinet) could be used. Input/output ➤

➤ +128 to the exponent. Each "extended-precision" operand is represented by 3 words, which hold a fraction of 31 bits plus sign and an 8-bit characteristic formed as above.

INSTRUCTIONS: One or two 16-bit words per instruction. There are five classes of instructions: Load/Store, Arithmetic, Shift, Branch, and Input/Output. All Shift instructions have the short (1-word) format, whereas most of the other instructions can have either the short or long (2-word) format.

The short instruction format consists of a 5-bit operation code, a 1-bit format designator (always "0"), a 2-bit index register tag, and an 8-bit displacement. The displacement is added to the contents of the Instruction Address Register or one of three index registers, as specified by the tag, to form the effective address.

The long instruction format consists of a 5-bit operation code, a 1-bit format designator (always "1"), a 2-bit index register tag, a 1-bit indirect addressing designator, 7 "modifier bits," and a 16-bit address. The address field may be modified by indexing and/or indirect addressing to form the effective operand address. The modifier bits have various uses in different instructions.

INTERNAL CODE: No fixed internal character code. The I/O devices use a number of different character codes, and frequent code conversions must be performed under program control.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CYCLE TIME: 3.6 microseconds/word in Models 1 and 2; 2.2 microseconds/word in Model 3.

CAPACITY: The available storage capacities and speeds can be summarized as follows.

Model	Capacity (16-bit words)	Cycle time (microseconds)
1A	4,096	3.6
1B	8,192	3.6
2A*	4,096	3.6
2B*	8,192	3.6
2C*	16,384	3.6
2D*	32,768	3.6
3B*	8,192	2.2
3C*	16,384	2.2
3D*	32,768	2.2

* Includes built-in Single-Disk Storage Drive.

CHECKING: Parity bit with each half-word is generated during writing and checked during reading.

STORAGE PROTECTION: None.

RESERVED STORAGE: 3 word locations (00001 through 00003) reserved for index registers, 6 for interrupt vectors, and 8 for the 1132 Printer scan field.

CENTRAL PROCESSORS

REGISTERS: The three hardware registers under direct program control are a 16-bit Instruction Address Register, ➤

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➤ capabilities were limited to paper tape reading at 60 characters per second, paper tape punching at 14.8 characters per second, card reading at 300 or 400 cards per minute, card punching at 80 or 160 columns per second, printing at 15.5 characters per second (on the console typewriter) or 80 alphanumeric lines per minute (on the 1132 Printer), and X-Y plotting at 200 or 300 steps per second.

In 1967 IBM responded to users' demands for increased 1130 capabilities by announcing a host of new hardware components. Core storage capacities of 16,384 and 32,768 words were added, in both the original 3.6-microsecond speed and a new 2.2-microsecond speed that yielded roughly a 63 percent increase in internal processing power. The 2310 Disk Storage drives were announced, enabling an 1130 to have up to 2,560,000 words of on-line storage in five independent single-disk drives. A Synchronous Communications Adapter enabled an 1130 to communicate with a remote IBM computer or terminal device, opening up a variety of new application possibilities. In addition, the fast 2501 Card Reader (600 or 1000 cpm), the buffered 1403 Printer (210, 340, or 600 lpm), the 1231 Optical Mark Page Reader, and the versatile but costly 2250 Display Unit were added to the list of 1130 I/O devices.

Thus, the 1130 is now available in a wide range of equipment configurations, with rental prices ranging from \$694 to over \$6,000 per month. Rentals for most of the installed systems fall below \$2,000, however, and an 1130 installation whose rental exceeds the \$3,000 mark is likely to be processor-bound and unable to take full advantage of its peripheral equipment.

The 1131 Central Processing Unit has a repertoire of 29 instructions, most of which can be used in either a short (1-word) or long (2-word) format. A 2-word instruction can directly specify any core storage address, while 1-word instructions use a base-plus-displacement addressing technique. Three index registers and an indirect addressing capability are provided.

Full fixed-point binary arithmetic facilities are included for 1-word (16-bit) operands, as well as addition and subtraction instructions for 2-word operands. But the 1130 offers no instructions to handle floating-point arithmetic, editing, code translation, or radix conversion. As a result, most 1130's are forced to spend a large portion of their time executing the standard subroutines which perform these vital functions. Programming the 1130 at the assembly-language level is a fairly intricate process—but the great majority of 1130 users sidestep these complexities by doing virtually all of their programming in the procedure-oriented FORTRAN language.

Most of the 1130 peripheral equipment has been "borrowed" from the larger IBM computer lines and has earned ➤

➤ a single 16-bit Accumulator, and a 16-bit Accumulator Extension (Q register).

INDEXING: Three 16-bit index registers in core storage can be used to modify most instructions in both long and short format. Indexing generally adds 3.6 microseconds to the instruction execution time in Models 1 and 2, and 2.2 microseconds in Model 3.

INDIRECT ADDRESSING: Single-level indirect addressing may be specified for long-format instructions only; it adds 3.6 microseconds to the instruction execution time in Models 1 and 2, and 2.2 microseconds in Model 3. Indexing and indirect addressing can be combined.

INSTRUCTION REPERTOIRE: 29 instructions, all standard, are divided into five categories: 8 load and store instructions, 9 arithmetic instructions (including AND, OR, and Exclusive OR), 8 shift instructions (including No Operation), 3 branch instructions, and one input/output instruction. Full fixed-point binary arithmetic facilities (add, subtract, multiply, and divide) are included for one-word operands, as well as add and subtract instructions for two-word (32-bit) operands. Floating-point arithmetic instructions are not available.

INSTRUCTION TIMES (average, in microseconds):

	1-word instructions		2-word instructions	
	Models 1 & 2	Model 3	Models 1 & 2	Model 3
	Add/Subtract (16-bit)	8.0	4.9	11.2
Add/Subtract (32-bit)	12.2	7.5	15.3	9.4
Multiply (16-bit)	25.7	15.7	29.3	17.9
Divide (16-bit)	76.0	46.4	79.6	48.6
Load/Store (16-bit)	7.6	4.6	10.8	6.6
Load/Store (32-bit)	11.2	6.8	14.4	8.8
Conditional Transfer	3.6	2.2	7.2	4.4

INTERRUPT SYSTEM: Interrupts are generated only by peripheral devices. An interrupt signal causes storage of the Instruction Address Register's contents and a transfer of control to one of six interrupt subroutines, depending upon the cause of the interrupt. Most of the 1130 peripheral devices generate an interrupt each time a single character or column of data is transferred, but the disk units, the 2501 Card Reader, and the buffered 1403 Printer generate interrupts only upon completion of an operation.

INPUT/OUTPUT CONTROL

CONFIGURATION RULES: Every 1131 CPU includes a keyboard and console printer, rated at 15.5 characters per second. CPU Models 2 and 3 also include a built-in Single-Disk Storage Drive. The following I/O units can be connected directly to an 1131 CPU via the appropriate attachment features:

- One 1442 Card Read Punch, Model 6 or 7, or 1442 Card Punch, Model 5.
- One 2501 Card Reader, Model A1 or A2, or one 1231 Optical Mark Page Reader (with CPU Models 2 and 3 only).
- One 1134 Paper Tape Reader.
- One 1055 Paper Tape Punch.
- One 1132 Printer.
- One 1627 Plotter, Model 1 or 2.
- One Synchronous Communications Adapter.

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▷ a reputation for reliable, effective performance. The 1130 disk units, however, are a noteworthy exception. The single-disk drive in the 1131 Model 2 and 3 Central Processing Units, and the functionally equivalent 2310 Disk Storage drives, are used only in the 1130 system. Compared with other IBM disk drives, they have a limited storage capacity (512,000 words or 1,024,000 bytes per drive), a very slow access time (an average of 540 milliseconds per random access), and an unenviable reliability record. Several independent peripheral manufacturers, including Memorex and Intercomp, have responded to this product opportunity by offering 2310-compatible disk drives that promise increased performance and improved reliability.

Compatibility between the 1130 and other current computer systems is quite limited. There is no direct program compatibility, at the machine or assembly-language level, between the 1130 and any other IBM computer except the special-purpose 1800 Data Acquisition and Control System, which has essentially the same instruction repertoire. Programs written in 1130 FORTRAN, COBOL, or RPG, however, can usually be converted and recompiled for execution on a larger IBM computer (or on many competitive computers) without undue difficulty. The 1130 card and paper tape I/O units are not code-sensitive and can accommodate virtually any data codes; the necessary conversions to and from the 1130 internal code must be performed by programmed subroutines. The 1130's hardware capabilities for simultaneous I/O operations are often largely negated by the need to perform these time-consuming code translations upon most input and output data.

For a computer in its price class, the 1130 offers an impressive array of supporting software. There are two basic levels of support, called the Card/Paper Tape Programming System and the Disk Monitor System.

Users of non-disk 1130 systems are restricted to the Card/Paper Tape Programming System, which includes an assembler, a Basic FORTRAN compiler, a subroutine library, and a group of utility routines.

The great majority of 1130 users find it advantageous to spend the additional \$200 per month for the integrated disk storage drive. This enables them to use the Disk Monitor System, a batch-mode operating system that provides efficient compilation and execution, in stacked-job fashion, of programs coded in FORTRAN, RPG, or assembly language. Also available, but separately priced, is a compiler for a useful subset of the American National Standard COBOL language.

The Synchronous Communications Adapter is supported by several software packages that equip the 1130 to serve as an effective remote terminal for larger IBM computers. ▷

▶ A Storage Access Channel can be added to the 1131 to provide for the connection of user-supplied I/O equipment or (on CPU Models 2 and 3 only) a 2250 Display Unit or an 1133 Multiplex Control Enclosure. The 1133, with appropriate attachment features, permits connection of up to four 2310 Disk Storage drives, a 1403 Printer (Model 6 or 7), and/or a 2250 Display Unit.

I/O MODES: I/O data transfer operations are performed in one of two basic modes, "cycle-steal" or "direct program control," depending upon the I/O device involved.

Cycle-steal I/O operations, after initiation by the CPU, continue independently of the CPU program, "stealing" core storage cycles from the CPU for each word of I/O data transferred to or from storage. The CPU is interrupted only upon completion of each cycle-steal operation. I/O devices that operate in the cycle-steal mode include the 1403 Printer, 2501 Card Reader, 2250 Display Unit, and all disk drives.

In direct program control operations, the transfer of each character or column of I/O data must be individually programmed, and the CPU is interrupted after each transfer. I/O devices that operate in this mode include the 1442 Card Read Punch, 1134 Paper Tape Reader, 1055 Paper Tape Punch, 1132 Printer, 1231 Optical Mark Page Reader, 1627 Plotter, and Synchronous Communications Adapter.

SIMULTANEOUS OPERATIONS: At the hardware level, an 1131 CPU can simultaneously control a number of overlapping I/O operations. However, the complex programming required to initiate and control many of the I/O functions and to perform the associated code and format conversions will, in most cases, make it impractical to control more than one I/O data transfer operation at a time.

MASS STORAGE

1131 SINGLE-DISK STORAGE DRIVE: This drive is contained within the cabinet of every 1131 Model 2 or 3 Central Processing Unit. The drive unit holds one removable, single-disk IBM 2315 Disk Cartridge at a time. The access mechanism consists of two horizontal arms that straddle the disk and move in unison; each arm has one read/write head and serves one surface of the disk. There are 200 data tracks on each surface, and each track is divided into four 320-word sectors. Total storage capacity of each disk cartridge is 512,000 words. Modulo-4 checking is performed upon all data transfers between core and disk storage; each word location in disk storage consists of 16 data bits and 4 check bits. Disk write operations are normally followed by programmed read-check operations to ensure that the data was recorded correctly.

The disk access mechanism moves in increments of 2 cylinders at the rate of 15 milliseconds per increment, and a 22.5-millisecond stabilization period follows the last incremental movement. The resulting average head movement time for random disk accesses is 520 milliseconds. Average rotational delay is 20 milliseconds. Data transfer rate is 36,000 words per second. An interrupt is generated only at the end of each disk read, write, or seek operation. During a read or write operation, the disk unit "steals" a cycle from the CPU every 27.8 microseconds to permit transmission of the next word to or from core storage. ▶

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- Also available are standard subroutine packages that facilitate the coding, in FORTRAN, of a wide range of scientific and commercial functions.

Users of the 1130 can also take advantage of a large library of application programs developed by both IBM (in pre-unbundling days) and other 1130 users. The availability of these ready-made programs, which can save thousands of dollars worth of programming effort in many scientific applications, can be a major reason for choosing an 1130 at this comparatively late stage in its life cycle. □

- **2310 DISK STORAGE:** Provides additional random-access storage capabilities for 1130 systems. Available in two models: Model B1 has one disk drive and Model B2 has two disk drives. A maximum of four drives (i.e., two 2310 Model B2 units) can be connected to an 1131 Model 2 or 3 CPU by means of an 1133 Multiplex Control Enclosure equipped with a Channel Multiplexer and the appropriate Disk Control features. Each 2310 drive accommodates a single-disk 2315 Disk Cartridge and has the same functional specifications (capacity, access mechanism, checking, timing, etc.) as the 1131 Single-Disk Storage Drive described above. Thus, an 1130 system can have a maximum of 2,560,000 words of disk storage in five functionally identical drive units.

INPUT/OUTPUT UNITS

CONSOLE PRINTER: This device, an integral part of every 1131 Central Processing Unit, provides keyboard input via a typewriter-style keyboard and printed output via a Selectric-style printing element. Rated printing speed is 15.5 characters per second, and a pin-feed platen is standard. Associated switches, displays, and lights permit convenient control of the system by a seated operator.

1442 CARD READ PUNCH: Can read, punch, or read cards and punch additional data into them during the same pass. Has a 1200-card feed hopper, a single card feed path, and two program-selectable 1300-card stackers. Available in two models: Model 6 reads 300 cpm and punches 80 columns per second, while Model 7 reads 400 cpm and punches 160 columns per second. Standard 80-column cards are read and punched in card-image mode; code translations must be performed by the stored program. One 1442 Model 5 (below), 6, or 7 can be connected to any 1131 CPU via the appropriate attachment feature.

1442 CARD PUNCH, MODEL 5: Provides punched card output at 160 columns per second (91 to 355 cpm, depending on the position of the last column punched in each card). Has a 1200-card feed hopper and a single 1300-card stacker. Data to be punched must be in card-image form, with code translation performed by the stored program.

2501 CARD READER: Provides high-speed input from standard 80-column punched cards. Available in two models: Model A1 reads 600 cpm and Model A2 reads 1,000 cpm. Each model has a 1200-card feed hopper and a single 1300-card stacker. Code translation must be performed by the stored program. One 2501 (either model)

can be connected to an 1131 Model 2 or 3 CPU via a 2501 Attachment, an 1130/2501 Coupling, and an Expansion Adapter. When both a 2501 and a 1442 Model 6 or 7 Card Read Punch are used in the same system, the 2501 is considered the primary input unit.

1134 PAPER TAPE READER: Reads 8-channel, 1-inch-wide tape at 60 characters per second. Data is read into core storage as a direct image of the holes punched into the tape; any code translation must be performed by the stored program. Available in two models: Model 1 reads strips of tape only, while Model 2 is equipped with a supply reel and take-up reel, each with a 1000-foot capacity, for handling tape in either reel or strip form. One 1134 (either model) can be connected to any 1131 CPU via the 1134 Attachment. Systems with no card reader must be equipped with the 1134 Loader feature on the CPU, which permits program loading from paper tape.

1055 PAPER TAPE PUNCH: Punches data into 8-channel, 1-inch-wide tape at 14.8 characters per second. Data is punched as a direct image of the leftmost 8 bit positions of each addressed core storage location; any code translation must be performed by the stored program. A tape supply reel is standard, and a take-up reel is optional. Another optional feature accommodates edge-punched cards, from 4 to 16 inches long and up to 12 inches wide, with prepunched feed holes. One 1055 can be connected to any 1131 CPU via the 1055 Attachment.

1132 PRINTER: Prints up to 80 alphanumeric or 110 all-numeric lines per minute. Has 120 print positions, each served by a continuously rotating printwheel with a 48-character set. Accommodates continuous forms from 4.75 to 16.75 inches wide. Line spacing is 6 or 8 lines per inch, with vertical format controlled by a 12-channel paper tape loop. Skipping speed is approximately 10 inches per second. Programming of 1132 operations is quite complex, with 48 programmed print cycles (one for each possible character) required for each line printed. One 1132 can be connected to any 1131 CPU via the 1132 Attachment and the Expansion Adapter.

1403 PRINTER: Provides high-speed, buffered printing by means of a horizontal-chain mechanism. Available in two models: Model 6 prints up to 210 or 340 alphanumeric lines per minute (depending upon the attachment feature used), and Model 7 prints up to 600 alphanumeric lines per minute. Each model has 120 print positions and a 48-character set. Accommodates continuous forms from 3.5 to 18.75 inches wide. Line spacing is 6 or 8 lines per inch, with vertical format controlled by a 12-channel paper tape loop. Skipping speed is 33 inches per second. A full-line print buffer simplifies the programming of 1403 output operations and minimizes time demands on the CPU (only one core storage cycle per character printed). One 1403 Printer (Model 6 or 7) can be connected to an 1131 Model 2 or 3 CPU by means of an 1133 Multiplex Control Enclosure equipped with a Channel Multiplexer and the appropriate 1403 Adapter feature.

1231 OPTICAL MARK PAGE READER: Reads pencil-marked data from 8.5-by-11-inch sheets at a maximum speed of 2,000 sheets per hour. Each sheet can have up to 1,000 mark positions printed on a side, in 50 rows of 20 positions each. Data read by the 1231 is stored in sonic delay-line buffers, and each one-word transfer to 1130 core storage is individually programmed. One 1231 can be

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► connected to an 1131 Model 2 or 3 CPU via a 1231 Attachment and an Expansion Adapter. The 1231 must be equipped with the Asynchronous Mode feature. The 1231 and the 2501 Card Reader are mutually exclusive; only one can be used in an 1130 system.

1627 PLOTTER: This drum-type X-Y plotter, manufactured by California Computer Products Corporation, provides graphic output from an 1130 system. The recordings are produced by individually programmed 0.01-inch incremental movements of the pen (y-axis) and/or the paper (x-axis). The 1627 is available in two models: Model 1 accommodates 12-inch-wide forms and plots up to 300 increments per second, while Model 2 accommodates 20-inch-wide forms and plots up to 200 increments per second. Both models accept 120-foot rolls of chart paper. Either model can be connected to any 1131 CPU via the appropriate 1627 Attachment.

2250 DISPLAY UNIT, MODEL 4: Displays data in either alphanumeric or graphic (line drawing) form in a 12-by-12-inch area on the face of a 21-inch CRT. Displays up to 52 lines of 74 characters each, and provides format flexibility to position characters, points, and vector end-points anywhere on a 1024-by-1024-position grid. A light pen allows program detection of specific displayed points or characters indicated by the operator. An optional typewriter-style keyboard permits entry of alphanumeric data. Another option, the 32-key Program Function Keyboard, facilitates the initiation of specific functions. One 2250 Model 4 can be connected to an 1131 Model 2 or 3 CPU via either the Storage Access Channel on the CPU or the Storage Access Channel II on the 1133 Multiplex Control Enclosure.

2285 DISPLAY COPIER: Provides an 8.5-by-11-inch paper copy of the image on the screen of a 2250 Display Unit upon request by the operator. No programming is required. Connects directly to the 2250 via the Display Copier Attachment feature. A dry development process is used, and each copy is available in 15 to 38 seconds, depending upon the exposure.

COMMUNICATIONS CONTROL

SYNCHRONOUS COMMUNICATIONS ADAPTER: This optional feature, contained within the 1131 CPU, equips the 1130 to function as a data transmission terminal and communicate, via a single switched or leased line, with various IBM (or equivalent) computers and terminals. Data is transmitted and received in half-duplex mode over either 2-wire or 4-wire transmission facilities, using either the Binary Synchronous Communications (BSC) or Synchronous Transmit Receive (STR) mode. Transmission is at 600, 1200, 2000, 2400, or 4800 bps in BSC mode, and at 600, 1200, 2000, or 2400 bps in STR mode. In BSC mode, an 1130 can communicate with another similarly equipped 1130, with a suitably equipped System/360, System/370, or 1800 computer, or with a 2770 Data Communication System or 2780 Data Transmission Terminal. In STR mode, an 1130 can communicate with another 1130, with a System/360 or System/370 computer, or with a 1009 Data Transmission Unit, a 1013 Card Transmission Terminal, a 7702 Magnetic Tape Transmission Terminal, or a 7711 Data Communication Unit. All data transmission operations must be programmed on a character-by-character basis, and strict timing requirements must be satisfied to prevent overruns when receiving or character gaps when transmitting.

MULTIPLE TERMINAL COMMUNICATIONS ADAPTER: This special-order device, introduced early in 1970, permits an 1130 to communicate with teletypewriters or IBM 2741 Communications Terminals over as many as 16 remote and local lines. Thus, the 1130 can act as a message switching or inquiry processing system. The MTCA can be connected to an 1131 Model 2 or 3 CPU with at least 8,192 words of core storage. Prices vary according to the type and number of connected terminals and lines; an MTCA controlling six 2741 terminals over a switched telephone network, for example, would rent for \$518 per month or sell for \$21,530.

SOFTWARE

PROGRAMMING SYSTEMS: IBM software for the 1130 is divided into two basic levels of support: the Card/Paper Tape Programming System and the Disk Monitor System. The facilities provided at each level are described in the following paragraphs.

IBM 1130 CARD/PAPER TAPE PROGRAMMING SYSTEM: This software system is designed for use on 1130 systems without disk storage. The minimum equipment configuration consists of a 4K 1131 Model 1A CPU and either an 1134 Paper Tape Reader and 1055 Paper Tape Punch or a 1442 Card Read Punch, Model 6 or 7. Also supported are the 1131 Model 1B, 2A, and 2B CPU'S, the 1132 Printer, the 1627 Plotter, the Synchronous Communications Adapter, and the Single-Disk Storage Drive in the Model 2A or 2B CPU.

The Card/Paper Tape Programming System consists of an assembler, a Basic FORTRAN compiler, a subroutine library, and a group of utility routines. The assembler and compiler are described under the appropriate headings below. The subroutine library is a package of routines that perform a wide variety of common input/output control, code conversion, and arithmetic functions. The utility routines include relocating and core-image loaders, dump routines, a card reproducing routine, a disk pack initialization routine, a paper tape file maintenance routine, and a basic input/output routine that controls input from cards or paper tape and output to cards, paper tape, console printer, or an 1132 Printer.

IBM 1130 DISK MONITOR SYSTEM, VERSION 2: This software system enables users of disk-oriented 1130 computers to assemble, compile, and execute programs written in Assembler, FORTRAN, or RPG language. The system minimizes job set-up times and handles continuous processing of stacked jobs, but provides no multiprogramming capabilities. The minimum equipment configuration consists of a 4K 1131 Model 2A CPU and either a paper tape reader and punch or a card read/punch. The system supports the use of up to 32K words of core storage and all the standard 1130 peripheral devices.

The Disk Monitor System is composed of a supervisor program, assembler, FORTRAN compiler, RPG processor, system library, disk utility program, core load builder, and core image loader. The assembler, FORTRAN compiler, and RPG processor are described under the appropriate headings below.

The Disk Monitor supervisor reads and analyzes monitor control records and transfers control to the proper program; the control records can be entered via cards, paper ►

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▶ tape, or the console keyboard. The system library contains all the input/output, code conversion, and arithmetic subroutines in the Card/Paper Tape Programming System library plus additional interrupt servicing, communications, conversion, and utility routines; the communications subroutines control transmission and reception, in BSC or STR mode, between the 1130 and numerous other IBM computers and terminals. The disk utility program aids in managing programs and data files in disk storage by facilitating additions, deletions, and replacements. The core load builder builds a specified program into an executable "core load" by adding the required subprograms and converting the format into a core image that can be executed immediately or stored on disk for future execution. The core image loader locates and fetches the specified core load for execution.

COBOL: The COBOL compiler for the 1130 is a separately priced IBM Program Product, announced in April 1970 and scheduled for delivery in February 1971. The compiler operates under control of the Disk Monitor System, Version 2, and requires at least 8K words of core storage, one disk drive, a line printer, and a card read/punch. The IBM 1130 COBOL language includes five modules of American National Standard (formerly USASI) COBOL, as well as certain IBM extensions. The five ANS COBOL modules are Nucleus (Level 1), Sequential Access (Level 1), Table Handling (Level 2), Random Access (Level 1), and Library (Level 2); the ANS Segmentation, Report Writer, and Sort modules are not implemented.

FORTRAN: Compilers for FORTRAN, the most popular programming language for the 1130, are included in both the Card/Paper Tape Programming System and the Disk Monitor System. Both compilers use essentially the same language, called IBM 1130 Basic FORTRAN IV. This language encompasses American National Standard (formerly USASI) Basic FORTRAN plus some useful IBM extensions. (The Card/Paper Tape version, however, lacks the REWIND, BACKSPACE, ENDFILE, and unformatted READ and WRITE statements of ANS Basic FORTRAN.) Among the IBM extensions are 3-dimensional arrays, extended-range DO statements, mixed-mode arithmetic, literal format specifications, the EXTERNAL and TYPE statements, expressions of the form A**B**C, and—in the Disk Monitor version only—disk I/O statements, the DATA statement, and the T format specification. But 1130 FORTRAN lacks facilities for complex, double-precision, and logical operations.

The Card/Paper Tape FORTRAN compiler requires at least 4,096 words of core storage and either a card read/punch or a paper tape reader and punch. FORTRAN source programs, entered via cards or paper tape, are compiled into machine-language object programs on cards or paper tape, ready for loading and execution. The relocating loader selects and generates linkages for the required subroutines. Compilation of a 150-statement source program that yields a 50-card object deck will take about 2.75 minutes if a 1442 Model 7 Card Read Punch is used and no listing is required.

The Disk Monitor FORTRAN compiler requires at least 4K words of core storage, one disk drive, and either a card read/punch or a paper tape reader and punch. FORTRAN source programs, entered via cards or paper tape, are compiled into relocatable object programs in disk storage. The object programs can be loaded for execution, inserted into a disk library, and/or punched as binary card decks

or paper tapes. Compilation of a 150-statement source program will take about 1.8 minutes if a 1442 Model 7 Card Read Punch is used for input and no listing is required. (Producing a listing on the 1132 Printer or Console Printer would raise the total compilation time to about 3.8 or 7.2 minutes, respectively.)

RPG: A Report Program Generator that operates under the Disk Monitor System, Version 2, facilitates the programming of many commercial applications for the 1130. The 1130 RPG language uses the same coding forms as System/360 RPG and provides similar functional capabilities, though there are a number of incompatibilities. The programmer prepares a set of specifications describing the input data, calculations, and desired output. The RPG then generates a machine-language program that is executed to perform the required functions. The RPG requires at least 8,192 words of core storage, one disk drive, a card reader or read/punch, and a printer (1132, 1403, or Console Printer); no RPG is available for paper-tape-oriented systems. Compilation of a 52-statement RPG source program that reads cards and produces an accounts receivable register takes about 20 seconds if a 2.2-microsecond CPU and a 1442 Model 7 Card Read Punch are used and no listing is required. (Producing a listing on the 1132 Printer or Console Printer would raise the total time to about 95 or 500 seconds, respectively.)

ASSEMBLERS: Both the Card/Paper Tape Programming System and the Disk Monitor System include assemblers, which permit programs to be coded in a machine-oriented language that uses symbolic operands and mnemonic operation codes. A fixed-format coding form is used, and most symbolic instructions are converted into machine instructions on a one-for-one basis. A number of pseudo-instructions are used to define constants and control the assembly process.

The Card/Paper Tape Assembler requires at least 4K words of core storage and either a card read/punch or a paper tape reader and punch. A two-pass assembler, it accepts source programs and produces object programs on either cards or punched tape. Approximately 520 symbolic labels can be held in a 4K core memory. Assembly speeds are generally input/output-limited, resulting in speeds of about 90 to 100 statements per minute for a card system with a 1442 Model 7 Card Read Punch and 6 to 17 statements per minute for a paper tape system.

The Disk Monitor Assembler is a disk-oriented assembler that produces object programs in disk storage and permits the label table to overflow onto the disk if necessary. A number of additional pseudo-instructions provide capabilities for disk data organization, program linking, and control of the assembly listing. Minimum equipment requirements are 4K words of core storage, one disk drive, and either a card read/punch or a paper tape reader and punch. Assembly speeds range from about 14 to 500 statements per minute, depending upon the equipment configuration and the listing requirements.

The 1130 Macro Assembler performs all the functions of the Disk Monitor Assembler described above. In addition, it provides facilities for defining, cataloging, and using user-defined macro-instructions, which can simplify programming and facilitate the development of specialized, application-oriented languages. At least 8K words of core storage are required for use of the macro facilities. ▶

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► **UTILITY ROUTINES:** The Card/Paper Tape Programming System and the Disk Monitor System each contain a variety of utility routines, as described above. In addition, the following facilities are available:

- **Graphic Subroutine Package (GSP):** Facilitates the programming of interactive graphic applications using the 2250 Display Unit; operates under the Disk Monitor System and requires at least 8K words of core storage.
- **Satellite Graphic Job Processor:** Permits definition and initiation of Operating System/360 jobs from a remote 1130 computer equipped with a 2250 Display Unit; requires a 16K 1130 with disk drive, card read/punch, display unit, and Synchronous Communications Adapter.
- **FORTRAN Subroutines for Data Transmission:** Permit FORTRAN programmers, by means of appropriate CALL statements, to control the transmission of data between a System/360 and a remote 1130 computer.
- **Remote Job Entry Work Station:** Permits entry of Operating System/360 jobs from a remote 1130 for execution on a System/360 computer.
- **Scientific Subroutine Package:** Consists of 121 FORTRAN-coded subroutines designed to handle a broad range of statistical, matrix manipulation, integration, polynomial evaluation, and other mathematical functions.
- **Commercial Subroutine Package:** Consists of 28 Assembler-language subroutines that can be called by FORTRAN programmers to facilitate the processing of variable-length decimal or alphanumeric fields and perform a variety of code and format conversions.

APPLICATION PROGRAMS: A large library of programs for specific applications, developed by both IBM and users, is available for the 1130. Type II programs, which receive full IBM support and are offered at no additional charge, include:

Automated Chemistry Programs
Civil Engineering Coordinate Geometry (COGO)
Continuous System Modeling
Control Optimization
Data Presentation System
Linear Programming/Mathematical Optimization
Mechanism Design System—Kinematics
Mechanism Design System—Springs and Gears
Optical System Design
Petroleum Engineering (15 programs)
Problem Language Analyzer (PLAN)
PLAN Graphic Support for 2250
Project Control System
Rigid Frame Selection Program
Route Accounting System
Statistical System
Structural Engineering System Solver (STRESS)
Type Composition
Work Measurement Aids

PRICING

EQUIPMENT: The following systems illustrate typical configurations of the IBM 1130. Obviously, they represent only a small sampling of the extensive configuration possibilities. All necessary features and adapters are included in the indicated prices, and the quoted rental prices include equipment maintenance.

MINIMUM PAPER TAPE SYSTEM: Consists of 4K 1131 Model 1A Central Processing Unit, 1134 Model 1 Paper Tape Reader, and 1055 Paper Tape Punch. Monthly rental and purchase prices are \$694 and \$30,100, respectively. Substitution of the 4K 1131 Model 2A CPU, which includes a single-disk storage drive, increases the rental and purchase prices to \$894 and \$38,005, respectively.

MINIMUM CARD SYSTEM: Consists of 4K 1131 Model 1A CPU and 1442 Model 6 Card Read Punch. Monthly rental and purchase prices are \$872 and \$40,725, respectively. Substitution of the 4K 1131 Model 2A CPU, which includes a single-disk storage drive, increases the rental and purchase prices to \$1,072 and \$48,630, respectively.

TYPICAL DISK/CARD/PRINTER SYSTEM: Consists of 8K 1131 Model 2B CPU with single-disk storage drive, 1442 Model 6 Card Read Punch, and 1132 Printer. Monthly rental and purchase prices are \$1,547 and \$68,780, respectively. Substitution of the faster 1131 Model 3B CPU increases the rental and purchase prices to \$1,877 and \$83,615, respectively.

EXPANDED DISK/CARD/PRINTER SYSTEM: Consists of 32K 1131 Model 3D CPU with single-disk storage drive, 1133 Multiplex Control Enclosure, four 2310 Disk Storage drives, 2501 Model A2 Card Reader, 1442 Model 5 Card Punch, and 1403 Model 7 Printer. Monthly rental and purchase prices are \$5,979 and \$267,835, respectively.

SOFTWARE: Most of the existing IBM 1130 software was being distributed prior to IBM's June 1969 unbundling announcement, and is therefore available to users at no additional charge. Only a few separately priced Program Products for the 1130 have been announced to date: the COBOL Compiler (described above), Charge Materials Allocation Processor, Construction Estimating Program, and Linear Programming System.

SUPPORT: IBM Systems Engineering assistance is available to 1130 users at a basic rate of \$220 per hour.

EDUCATION: All IBM "professional courses" are now individually priced. System Features Instruction is offered to users of IBM computers at no charge. Customer Executive Seminars, Industry Seminars, and promotional sessions are still offered at no charge by IBM invitation.

CONTRACT TERMS: The standard IBM rental contract includes equipment maintenance and entitles the user to up to 176 hours of billable time per month. Time used in excess of that amount is billed, for most 1130 components, at an extra-use rate of 10% of the basic hourly rate (i.e., 10% of 1/176 of the monthly rental for each hour of extra use). ■

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
PROCESSORS AND MAIN STORAGE				
1131	Central Processing Unit			
	Model 1A: 4,096 words, 3.6 microseconds, no disk	25,105	70.00	580
	Model 1B: 8,192 words, 3.6 microseconds, no disk	33,010	75.00	780
	Model 2A: 4,096 words, 3.6 microseconds, with disk	33,570	95.00	780
	Model 2B: 8,192 words, 3.6 microseconds, with disk	41,475	100.00	980
	Model 2C: 16,384 words, 3.6 microseconds, with disk	63,000	150.00	1,465
	Model 2D: 32,768 words, 3.6 microseconds, with disk	104,710	165.00	2,435
	Model 3B: 8,192 words, 2.2 microseconds, with disk	56,310	145.00	1,310
	Model 3C: 16,384 words, 2.2 microseconds, with disk	81,335	155.00	1,890
	Model 3D: 32,768 words, 2.2 microseconds, with disk	131,385	170.00	3,055
Features for 1131 Central Processing Unit				
3616	1132 Printer Attachment	450	2.00	10
3623	1134 Paper Tape Reader Attachment	450	1.75	10
3624	1134 Loader Feature	450	No charge	10
3854	Expansion Adapter	225	No charge	5
4449	1442 Model 5 Card Punch Attachment	1,480	3.00	35
4454	1442 Model 6 or 7 Card Read Punch Attachment	1,480	3.00	35
7187	1627 Model 1 Plotter Attachment	675	0.50	15
7189	1627 Model 2 Plotter Attachment	675	0.50	15
7490	Storage Access Channel	1,090	0.50	25
7690	Synchronous Communications Adapter	9,530	11.25	225
7923	1055 Paper Tape Punch Attachment	900	1.50	20
8034	1231 Optical Mark Page Reader Attachment	2,620	3.00	58
8042	2501 Card Reader Attachment	3,710	5.00	82
1133	Multiplex Control Enclosure	1,745	No charge	39
1865	Channel Multiplexer (for 1133)	5,500	10.00	110
3201	Disk Control 1 (for 1st 2310 drive, on 1133)	1,965	2.00	44
3202	Disk Control 2 (for 2nd 2310 drive, on 1133)	1,745	3.00	39
3203	Disk Control 3 (for 3rd 2310 drive, on 1133)	1,965	2.00	44
3204	Disk Control 4 (for 4th 2310 drive, on 1133)	1,745	3.00	39
4423	1403 Model 6 Printer Attachment; 210 lpm (for 1133)	10,000	30.00	200
4424	1403 Model 6 Printer Attachment; 340 lpm (for 1133)	19,640	30.00	435
4425	1403 Model 7 Printer Attachment; 600 lpm (for 1133)	21,825	35.00	485
7492	Storage Access Channel II (for 1133)	1,090	0.50	25
PERIPHERAL EQUIPMENT				
2310	Disk Storage			
	Model B1: one single-disk drive	11,785	41.00	262
	Model B2: two single-disk drives	18,990	73.00	420
2315	Disk Cartridge	90	Time & mat'ls.	Purchase only
1442	Card Read Punch			
	Model 6: reads 300 cpm, punches 80 cols/sec.	14,140	51.00	257
	Model 7: reads 400 cpm, punches 160 cols/sec.	15,255	61.00	370
1442	Card Punch, Model 5; punches 160 cols/sec.	12,365	49.00	247
3630	1130/1442 Coupling (required on 1442 Model 5 only)	225	No charge	5
2501	Card Reader			
	Model A1: 600 cpm	11,010	33.25	195
	Model A2: 1000 cpm	11,240	45.75	255
3630	1130/2501 Coupling (required on either model)	150	No charge	5
1134	Paper Tape Reader			
	Model 1: 60 chars/sec; for strips only	1,230	10.00	35
	Model 2: 60 chars/sec; for strips or reels	2,125	10.50	60
1055	Paper Tape Punch; 14.8 chars/sec.	1,965	6.50	39
3571	Edge-Punching (for 1055)	245	0.25	5
6121	Take-Up Reel (for 1055)	120	0.25	3
1132	Printer; 80 lpm, 120 print positions	11,010	25.00	260
1403	Printer			
	Model 6: 210 lpm (with 4423 on 1131 CPU) or 340 lpm (with 4424 on 1131 CPU)	28,130	105.00	390
	Model 7: 600 lpm (with 4425 on 1131 CPU)	31,720	124.00	630
1231	Optical Mark Page Reader, Model 1	22,405	36.25	415
1264	Asynchronous Mode Feature (required on 1231)	1,745	4.00	39
1627	Plotter			
	Model 1: 300 increments/sec, 12" wide chart	4,560	36.00	Purchase only
	Model 2: 200 increments/sec, 30" wide chart	7,905	38.50	Purchase only
2250	Display Unit, Model 4	111,745	89.00	2,330
1248	Alphameric Keyboard (for 2250)	3,490	2.00	73
3252	Display Copier Attachment (for 2250)	3,260	2.00	68
5858	Program Function Keyboard (for 2250)	6,985	2.50	145
2285	Display Copier	29,335	120.00	610

* Rental prices include equipment maintenance.