

Technical Summary

HEWLETT  PACKARD

*William Hewlett*

# HP 3000 Series II Systems

A computer advance in data  
processing price/performance



# HP 3000 Series II Systems

## Powerful, new general purpose computers

Today, quick access to timely and complete data often makes the critical difference in an organization's capital resource allocations, financial health, sales forecasting, research results, or other activities. Instead of basing decisions on educated guesses, sound management practices demand that information on all phases of an organization's affairs be accurate. To solve the inherent data handling problems, Hewlett-Packard introduces a family of powerful, new computers—the HP 3000 Series II Systems.

Designed for small-to-medium businesses or divisions of larger corporations, educational institutions, and scientific computer users, the HP 3000 represents a new state-of-the-art in low cost, disc-based computer systems. With exceptional processing capabilities, large memory capacity, and convenient operation, Series II systems present a fresh approach to data processing for many users of small general purpose computers.

Although the HP 3000 is a sophisticated system, it is so easy to use that a minimum of personnel training is required to bring its benefits to every department in your organization.

As a leader in small computers, Hewlett-Packard has contributed significantly to the technology during the past decade. Originally the computers were oriented toward scientific and engineering applications, but with such Hewlett-Packard innovations as multi-terminal RJE for small computers, timesharing systems for education, and concurrent multiple language processing with small systems, they quickly gained favor among educational, government, and business users as well. Over 13,000 Hewlett-Packard computers are currently in use around the world.



# System Capabilities

## High performance for batch and terminal-oriented tasks



In planning the HP 3000 Series II Systems, a major design criterion was to make them versatile enough to adapt to a broad spectrum of applications and yet maintain optimum performance in a dedicated environment. This design goal was applied to software as well as hardware. As an integrated combination of software and hardware, the HP 3000 is a powerful tool for solving data processing problems. The system capabilities discussed below suggest how the HP 3000 can be used successfully in your organization.

**Concurrent Processing:** HP 3000 systems manage both batch jobs and multiple interactive (on-line) terminals at the same time. Employing an integrated terminal handling technique, the central processor switches between batch jobs and terminals, as required, to optimize throughput and turnaround.

**Application Program Development:** Presently, with hardware costs decreasing at a steady rate, the most expensive component of a computer system is the development of software. On-line program development minimizes software costs by reducing turnaround time and providing instantaneous access during the debug and test cycles. Programs can be written in five languages—COBOL, RPG, FORTRAN, BASIC, and SPL (Systems Programming Language).

**High Data Throughput:** The system's basic structure of independent modules organized around an input/output processor bus and a central data bus permits high speed internal data rates. A central selector channel provides a direct port to the central data line for high speed I/O devices, transferring data in and out at rates up to 2.86 million bytes/sec. Double buffering, the accessibility of numerous I/O devices, and separate input/output and central processors further speed up data throughput.

**Data Entry/Validation:** Terminal-oriented processing allows data to be entered and validated simultaneously. Validation is done by a user's program performing edit checking functions. The information gathered in this manner is stored or immediately processed. Unauthorized use of programs or data files is prevented through a multi-level security system.

**Terminal Capabilities:** A major advantage of the HP 3000 is its ability to accommodate CRT or hard copy interactive terminals for a wide range of applications such as program development, problem-solving, data base inquiry, or on-line data entry. Users have full access to the system utilities. Terminals may be hardwired to the system or connected through a modem.

**Data Inquiry:** Since terminal orientation allows the data bases to be kept up-to-date, users can obtain information from the system in an ad hoc fashion at any time, within security limits. Terminal-oriented processing not only brings computer power to the user, but also contributes to the overall accuracy of information. Typical data inquiries include:

- Locating parts in a warehouse
- Checking inventory levels
- Issuing back orders
- Supervising shipments.

**Multiprogramming:** The operating system of the HP 3000 makes it possible to execute multiple jobs or programs at the same time and thus, in effect, process more work in a given period. This feature is one of the reasons the system outperforms competitive computers of comparable size and cost. The number of jobs and sessions executed simultaneously is controlled by the operator, and depends on the types of applications involved.

**Remote Job Entry:** A 2780/3780 emulator incorporated in the HP 3000 implements the remote job entry capabilities of the system. Data can be transferred between an HP 3000 and

other remote processors in a full multi-programmed environment over the public telephone (switched) network or a private line.

**Production:** Since HP 3000 systems can handle both batch jobs and multiple interactive terminals concurrently, they provide high productivity in any EDP environment. The system's flexibility means that as applications change in the future the cost effectiveness is maintained and productivity increased even further by the addition of more CRT or hard copy terminals, discs, and other peripherals. Major system growth can be accommodated by adding more memory and discs or another HP 3000.

**Teleprocessing:** Series II computers bring the advantages of teleprocessing to small, low-cost systems. By teleprocessing we mean the facility for a terminal user to enter raw data at a remote terminal, have this data transferred via telephone lines to an HP 3000 and processed, then have the processed data returned to the terminal. Teleprocessing puts the computer's resources at the operator's fingertips, even if the computer is miles away.



*With concurrent batch and terminal processing, the HP 3000 adapts to your applications requirements and system resources are employed efficiently.*

# System Configurations

## Three models to meet a wide range of needs

Hewlett-Packard 3000 Series II Computer Systems are available in three standard configurations—Models 5, 7 and 9. Customized configurations may also be assembled simply by adding more memory and a variety of peripherals. The systems are designed to be fully compatible. Models 5 and 7 can be upgraded at any time to higher capability and performance standards with no applications software changes. This building-block design approach gives the option of beginning with a small system which meets present needs and adding to it in the future as work load and application requirements increase.

**Model 5:** Typical applications for this system include inventory control, order processing, cost collection, and other data processing functions encountered in a small commercial environment. It is also excellent for interactive scientific tasks. In many installations the Model 5 may serve as a satellite data center dedicated to a particular job, or may be used for remote data entry to the corporate data center where a more sophisticated HP 3000 or other computer is located. However, as with all HP 3000 systems, it has concurrent batch and terminal access capabilities to give it the flexibility to meet the demands of a variety of applications. Hardware components of this basic system are a 128k byte fault control memory (expandable to 256k), 15 megabyte disc, 1600 bpi magnetic tape unit, system console, and a 16-port asynchronous terminal controller.

**Model 7:** Increased performance capabilities for interactive and batch processing are offered by the Model 7 through the inclusion of a larger main memory. The enlarged main memory makes it possible for more terminals to operate simultaneously with shorter response times. Additional disc capacity is included to meet the on-line storage requirements of many business and administrative applications. The Model 7 configuration can perform all the data processing functions required in many small and medium size organizations. It could also be networked to a larger system. Model 7 hardware includes a 192k byte fault control memory (expandable to 256k), two 47 megabyte disc units, 1600 bpi magnetic tape unit, system console, and a 16-port asynchronous terminal controller. IMAGE data base management software plus COBOL and RPG compilers are supplied with the system.

**Model 9:** This system offers the greatest processing power of any of the standard configurations to satisfy the demands of general computing applications. With its 320k byte main memory and large disc storage, it supports multiple terminal and batch devices performing a variety of tasks. The standard system is configured with a 320k byte fault control memory (expandable to 512k), two 47 megabyte discs, 1600 bpi magnetic tape unit, system console, and a 16-port asynchronous terminal controller. COBOL, RPG, FORTRAN, BASIC, and SPL language processors and the IMAGE data base management software are also included.

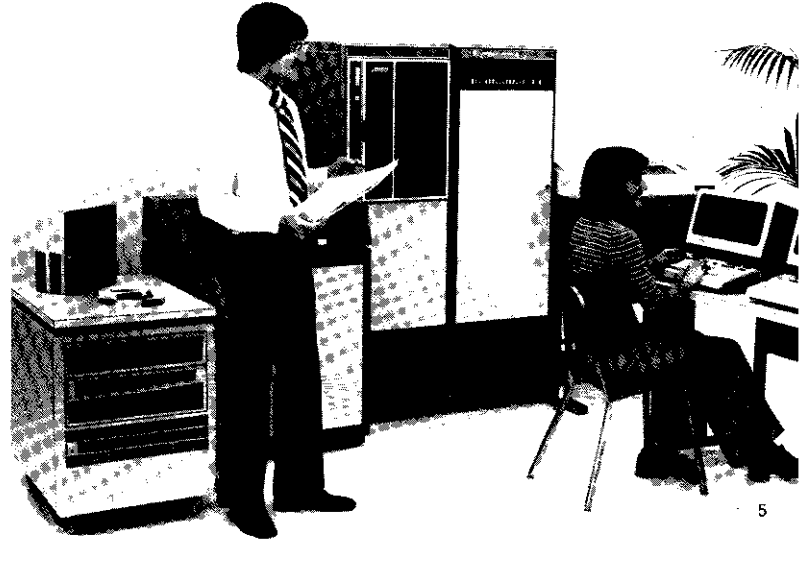
The performance of any of the standard HP 3000 Series II configurations can be enhanced with the addition of Hewlett-Packard line printers, card readers and punches, terminals, discs, and main memory. You may order auxiliary equipment with the system or add it later.

*As shown in this expanded Model 9, HP 3000 Systems can be configured to meet your needs by adding memory and peripherals.*



Model 7 with added peripherals.

Typical Model 5 configuration.



# HP 3000 Hardware

## Superior features for optimum performance

Hewlett-Packard 3000 Series II Systems combine hardware and software features to present the most effective answer to your data handling needs. A creative approach has been taken in many instances to find the optimum method for performing certain DP operations.

As indicated in the architecture diagram, the HP 3000's hardware embodies a dual-bus architecture providing for interconnection of the various system modules. A high-speed central data bus allows for efficient transfers between memory and processor modules, while a slower input/output processor bus transfers data to and from slower I/O devices. A selector channel provides a high-speed port to the central data bus to accommodate very fast I/O devices such as high-speed disc drives. The I/O processor, in conjunction with the multiplexer channel, allows execution of I/O programs for slower speed devices, independent of central processor activity. The selector channel contains a processor to provide this capability for

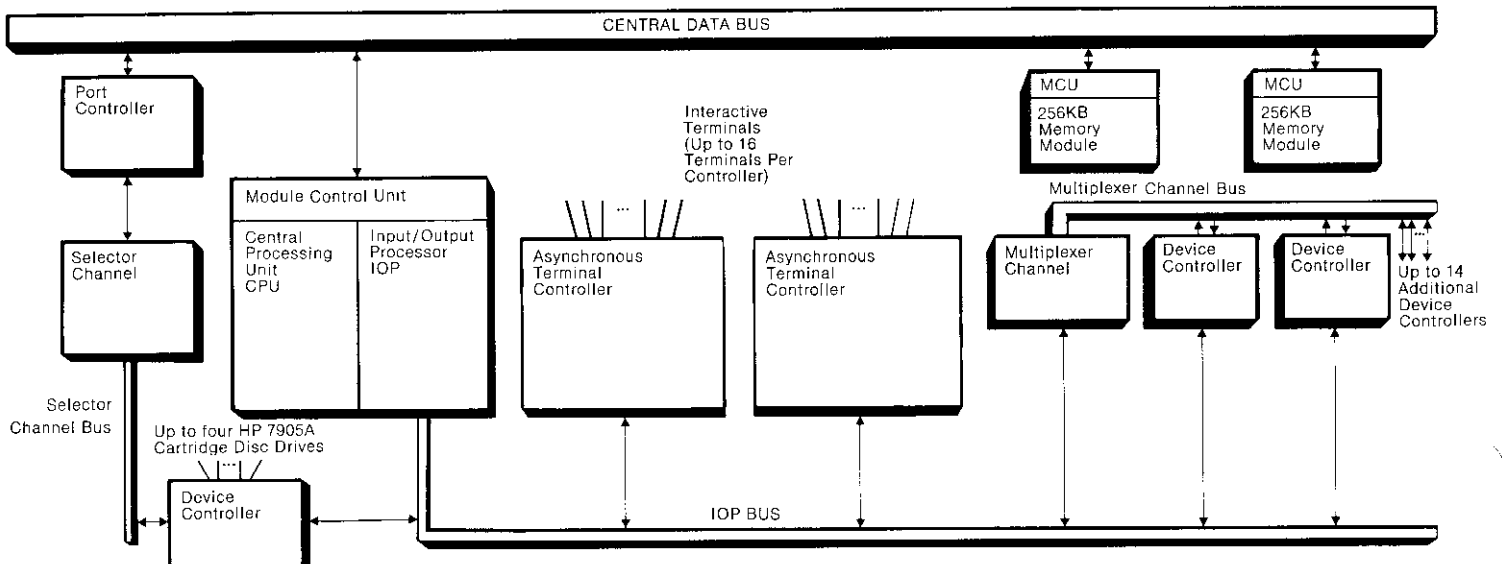
higher speed devices. This design approach leads to more efficient multi-programming operation. A few of the important hardware features are highlighted below.

**Stack-oriented Architecture:** Many powerful operating system features are realized through the computer's use of true hardware stacks, or linear data storage areas. In general, a stack is a storage area where the last item stored is always the first item taken out. Such a scheme provides an efficient mechanism for parameter passing, dynamic allocation of temporary storage, efficient evaluation of arithmetic expressions, and recursive subroutine or procedure calls. Stack architecture reduces system overhead by eliminating addresses in some instructions. The main benefits of the stack-oriented architecture are that it improves throughput, reduces program size, and enables rapid context switching. All features of the stack are implemented in the hardware.

**Central Processing Unit:** This high speed unit incorporates three components: Instruction decoder, processing registers, and an arithmetic logic unit. The instruction decoder receives instruction words from memory and translates them into microprogram starting addresses. Processing registers contain code and data segment limits and operating elements within the segments. Various arithmetic and logical functions are performed by the arithmetic logic. Together these components execute over five million micro-instructions per second.

A "pipeline" method for processing data in the instruction decoder is implemented by two special registers called the Current Instruction Register (CIR) and the Next Instruction Register (NIR). While one instruction is executing, the second is being fetched from memory. This continuous data flow increases throughput.

### HP 3000 Series II System Architecture



**Microprogrammed Operation:** A 32-bit bipolar ROM-based microprocessor is the heart of the HP 3000. It contains 209 unique firmware instructions to control the CPU and I/O functions.

Numerous system operations normally accomplished through software are executed in the HP 3000 with microinstructions in the microprocessor. Microprogramming eliminates repetitive coding and main memory requirements otherwise needed for recurring operations such as moving character strings from one location to another, scanning strings for a particular character, or environment switching. Also, a number of important operating system functions are implemented in microcode including processing interrupts and link list searches. Microprogramming relieves the operating software of a significant overhead burden.

**Input/Output Processor:** Typically found only in large-scale batch computers, the separate input/output processor in the HP 3000 Series II Systems controls data transfers between the multiplexer channel and memory, checks peripheral status, and monitors all data transfers. Separation of the CPU and the I/O processors makes it possible for the HP 3000 to perform calculations and transfer data at the same time. This is accomplished by the IOP initiating channel programs which execute in the multiplexer or selector channels while the CPU continues processing.

**Central Data Bus:** Data communications and transfers between memory and processor modules occur via the central data bus, which connects each component through module control units or port controllers. With a transfer rate of 2.86 million bytes per second, data is moved efficiently and accurately to its destination.

**I/O Processor Bus:** The Input/Output Processor (IOP) bus serves as the interface between external peripherals and the processors. In this function, the bus helps transmit data to the user in a timely manner.

**Fault Control Memory:** An HP 3000 System can be expanded to contain up to 512k bytes of MOS semiconductor main memory. Memory consists entirely of high density 4K metallic oxide semiconductor (MOS) random access memories (RAMs). Enough capacity is provided by main memory to handle all but the very largest set of applications.

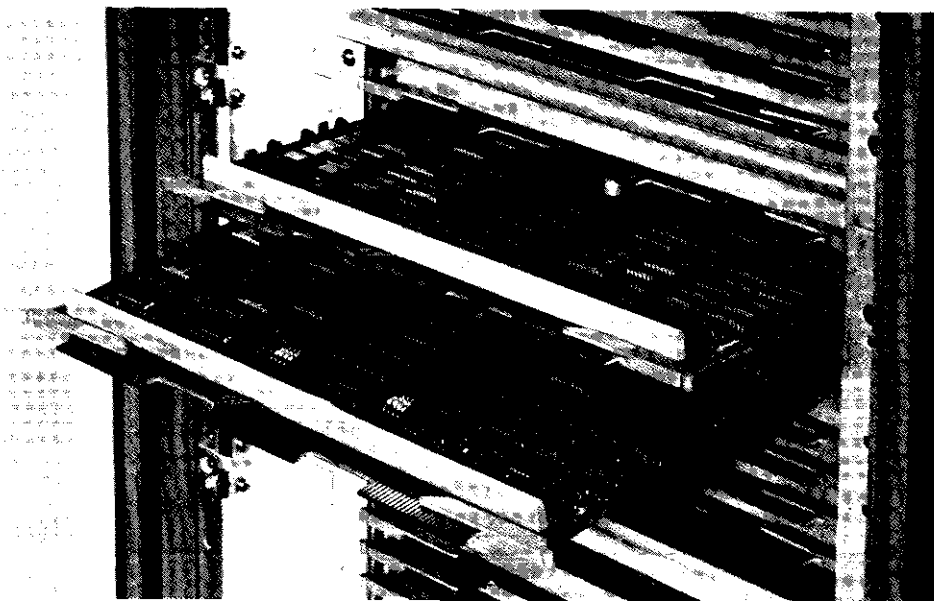
In addition to capacity, a significant new characteristic you'll appreciate is the ability of the HP 3000's main memory to detect and correct single-bit errors. Five checking bits determine when a single-bit error occurs in any 16-bit word, and pinpoint exactly which bit is failing (even if it's one of the checking bits). The error is corrected and the failure recorded in a logging RAM. This RAM is read periodically by the operating system, and its information recorded in a file which is accessible to a service engineer. By reading this file, the service engineer can immediately determine which chip is faulty and replace it quickly during normal preventive maintenance. This error detection and correction feature is completely transparent to the user.

*MOS semiconductor memory can be expanded up to 512k bytes. The fault control feature automatically detects and corrects single-bit errors.*

**Multiplexer Channel:** Peripherals other than terminals and high-speed discs interface to the input/output processor through a 950 kilobyte/second multiplexer channel. This channel utilizes the I/O processor to execute I/O programs stored in main memory. Programs which control data transfer to up to 16 separate devices can be executed concurrently.

**Selector Channel:** A special selector channel accommodates the extremely high transfer rates provided by state-of-the-art peripherals. Capable of handling 2.86 megabytes per second, the selector channel controls peripheral interfacing through the device controller. The central data bus is accessible to the selector channel through its port controller. By dedicating a special port to high speed data transfers, the computer monitors these devices without sacrificing response to terminal-oriented users.

**Asynchronous Terminal Controller:** Each controller provides concurrent access to 16 terminals, which can be locally hardwired or remotely connected through modems (modem hook-up is an option with Model 5 systems). An auto speed sensing feature in the controller senses and adjusts to the baud rate of each terminal.



# HP 3000 Software

## Multiprogramming Executive II Operating System

Operating efficiency in the HP 3000 Series II is achieved through the disc-based Multiprogramming Executive operating system (MPE II), which controls concurrent processing of multiple user programs by the expedient allocation and scheduling of system resources. For example, if a program is awaiting an I/O operation, or some other event, control of the central processor is switched to another program according to priorities controlled by the system manager. This automatic switching between various programs minimizes CPU idle time. MPE II significantly increases the total volume of work the system is able to perform in a given time interval without appreciably affecting individual programs.

The operating system supports five programming languages—COBOL, RPG, FORTRAN, BASIC, and SPL (System Programming Language). Because the operating system is common to all Series II systems, no reprogramming is required to upgrade the computer system. MPE II provides efficient management of system resources through the implementation of the following concepts.

**Separation of Code and Data:** In conventional computer programs, instructions and data are intermixed; therefore, it is difficult to write shareable programs, and extensive memory is required to implement multiprogramming. Executing HP 3000 object programs are separated into permanent program instructions (code) and program temporary values (data). Each occupies a separate group of memory locations. Because code is unalterable, it can be shared among multiple users. For example, if five users are compiling COBOL programs simultaneously, each has a separate data space (or working storage), but all share the same copy of the COBOL compiler. Traditional architecture would require that five copies of the compiler be in memory—an obvious extravagance. In other words, the fact that code is not

alterable during execution means that all programs written for the HP 3000 are automatically re-entrant. This fact also means that when a piece of code is no longer needed in main memory, it simply may be overwritten; there is no need to swap it out to disc storage, since it has not been altered after it was originally loaded. Swap times are thus reduced and system throughput increased.

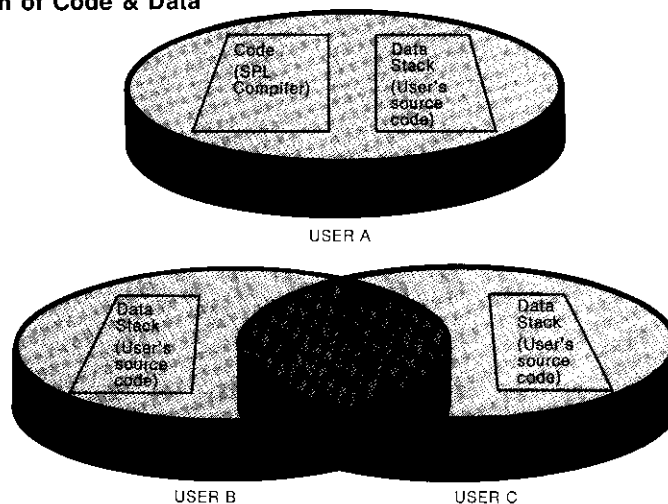
**Virtual Memory:** To expand the amount of memory space available to the user, HP 3000 computers employ an efficient memory management scheme called virtual memory. In such a system, disc memory is used as an adjunct to main (semiconductor) memory so that large programs can be executed.

Programs are divided into code and data segments which reside in the virtual (disc) memory. Only those code and data segments required at a particular time are located in main memory. If a code segment is no longer needed in main memory, it is overwritten by a new segment.

Data segments, however, are dynamic and their contents can change during execution. For this reason, when a data segment is no longer needed in main memory, it is automatically copied back to the disc, replacing the previous disc version of that segment. The main memory segment may then be overwritten with a new one. This memory management process is completely transparent to the user. The application programmer need not concern himself with this overlay or swapping process—it is handled automatically by MPE II.

**Main Memory Allocation:** High performance multiprogramming operation requires that main memory be efficiently allocated to those programs that need it most. In the HP 3000 Series II this is accomplished by maintaining a list of frequently-used code and data segments for each program running. This list is called the program's working set, and is maintained through the use of a new segment trap frequency replacement algorithm which adds and deletes segments, based on continuing fre-

### Separation of Code & Data



*To conserve memory, code portions of object programs can be shared by several users simultaneously. This eliminates the need to have multiple copies of the code in memory. Data remains private.*





quency of use. MPE II attempts to keep as much as necessary of each program's current working set in main memory, thereby decreasing swapping and increasing system throughput.

**Scheduling:** To achieve the desired level of performance, a multiprogramming system must permit the computer's resources to be shared fairly and efficiently among competing users, with minimum disruption of processing flow. An integrated approach to scheduling is embodied in the HP 3000 Series II. The dispatcher works closely with the memory manager to minimize the number of times a process must be dispatched. Substantial assistance is also received from special machine instructions which contain microcode to execute frequently-used operations. The system supervisor can dynamically adjust the dispatcher on-line to favor either batch or terminal users, as needs change.

**File System:** The operating system accomplishes the sophisticated data handling requirements through an efficient file system. Working with the input/output processor, file manipulation is done without extensive JCL. All I/O is handled by the file system so programs become device-independent and needless re-compilations are avoided. Security is maintained in any access mode, sequential or direct. By dedicating software to data-oriented hardware, the HP 3000 takes full advantage of a multiprogramming environment.

**Security:** Data protection in an on-line, multiprogramming environment is another MPE II feature. Passwords are attached optionally to users, groups, accounts, and individual files to produce a multilevel security system. And the file system attaches access levels to each file to totally restrict read, write, or read/write from users in other groups or accounts. By maintaining this type of security system, MPE II definitely prevents unauthorized access to any information stored in the system.

**Spooling:** Frequently the input/output limitations of a computer system are set by such peripheral devices as card readers, magnetic tape drives, or line printers. An inefficient system design can waste the capabilities of the CPU by causing it to wait on peripherals to finish a job. To alleviate this problem, HP 3000 systems incorporate an automatic spooling feature which allows concurrent use of devices that would otherwise be non-shareable.

With spooling, if several operations need the line printer, for instance, the first priority job will be printed and the others will be stored on disc until the printer is free. They will then be printed automatically, on a priority basis. In this way each user can immediately proceed with other processing activities and not have to wait for the printer. In the same manner the CPU can output data to spooling discs and continue with other jobs.

Batch job input spooling can be initiated not only from a card reader or magnetic tape drive, but also from an interactive terminal by means of the STREAM command. This command initiates the input of a job for concurrent processing with the user session.

The spooling system in the HP 3000 is designed so users are unaware files are being spooled. Spooling is controlled entirely by the console operator and is adaptable to batch or interactive session processing.

**Jobs/Sessions:** Batch processing (jobs) and terminal-oriented processing (sessions) are handled with equal facility by the HP 3000. Programs actuate internal system processes regardless of the initiating device. There is only one difference in executing a program from a terminal and from a card reader. If a critical, unanticipated processing error occurs in a job, it will automatically terminate to prevent damage to the files. In a session, an error terminates the executing program process only; the terminal user then has the capability to correct the error and continue the process.

**Accounting:** To keep track of machine costs and provide some structure for individual users, MPE II contains a complete accounting scheme. Unique accounts are set up by the system manager for each user's discipline. Accounts identify valid users by name and give them a home group for storing their program and data files. Partitioned groups are used to determine the file domain of an account.

Information about the machine's usage is kept by user, group, and account in log files automatically maintained in MPE II. Vital information like CPU time, connect time, and disc file space used can be extracted from the HP 3000 through a built-in REPORT command or a user-written program.

**File Maintenance:** To prevent the inadvertent loss of data, two utility subroutines (FCOPY and STORE/RESTORE) provide the means to create backup files. These files can be initiated quickly from an on-line terminal, and the delays inherent in batch access turnaround are avoided. A system backup facility is also provided, via the SYSDUMP command, which produces RESTORE compatible tapes.

# Data Base Management

## IMAGE/3000

To aid in the task of managing information, the HP 3000 Series II utilizes the powerful IMAGE/3000 Data Base Management System. IMAGE provides the means to create a data base, describe data base structures, and logically restructure, back up, and access the data. With this flexible tool the user can tailor his information system to fit his needs. Storing information in a data base simplifies the maintenance and manipulation of data and makes it easy to relate information for retrieval.

IMAGE operates concurrently in both terminal and batch environments within the constraints of an external (MPE II) and internal security scheme. Data between files can be related logically as well as physically. Files contain data and structural information. IMAGE maintains pointers to connect individual words within a file and between files into data chains, and to relate search indices to these data chains. This indexing property makes it possible to access related data rapidly. The overall use of IMAGE involves five general steps:

- Creating an external data base description.
- Building the internal data base description.
- Building the data base files.
- Accessing the data base.
- Maintaining the data base.

A data base is defined through the IMAGE/3000 Data Base Description Language (DBDL). This language specifies all aspects of the structure including:

### DATA ITEM

Smallest accessible unit of data, may consist of a field or a logically contiguous group of fields.

### DATA ENTRY

Groups of data items comprising a record or transaction.

### DATA SET

Collection of like-related data entries. Data sets reside in the disc files of the data base.

### PRIVACY

Provisions controlling read access to data items, entries, or sets.

### ACCESS METHOD

The technique for data storage and retrieval.

### CHAINING INFORMATION

Structural characteristics required for logical relationships.

**Data Base Access:** With COBOL, FORTRAN, BASIC, and SPL programs, access to a data base is through intrinsic or syntactic calls to IMAGE procedures. From RPG programs, access to the procedures is gained through the chain and ready statements after the data base has been declared in the file specifications section. These procedures locate data, maintain pointer information, manage the allocated file space, and return status information to the user. The tasks performed by the IMAGE procedures minimize the "book-keeping" normally associated with file management and permit the programmer to concentrate on his application with minimum concern about data and its structure.

IMAGE provides a set of library routines which are callable from user-written programs.

DBOPEN— initiates access to data base.

DBINFO— returns information about the data base currently being accessed.

DBGET— retrieves items from data entries.

DBPUT— adds new data entries.

DBLOCK— provides temporary exclusive control of a data base.

DBCLOSE— terminates access to a data base.

DBFIND— prepares for chained access to data entries.

DBUPDATE— modifies existing data entries.

DBDELETE— deletes data entries.

DBUNLOCK— relinquishes temporary exclusive control of a data base.

**Maintaining the Data Base:** Data integrity is maintained by a set of utilities that create, update, and back up the entire data base. Utilities handle data and root files and provide portability between Series II machines. The utilities are:

DBUTIL— allocates and initializes disc space for data base; re-initializes the data sets for data base back to empty condition; purges the root file and all data sets of data base.

DBSTORE— produces a physical copy of a data base on magnetic tape.

DBRESTOR— copies a data base from magnetic tape to disc.

DBUNLOAD— produces a logical copy (data only) of a data base on magnetic tape.

DBLOAD— loads data from a DBUNLOAD tape into an existing data base on disc.

Content of the data base or the content and related structural information can be copied to magnetic tape. The first option is useful for restructuring data bases while keeping the content intact.

# QUERY

## On-line inquiry facility



A self-contained language, QUERY provides the non-programmer a simple means to access the data base through the use of English language key words and other character strings. The user communicates with QUERY through 17 unique commands to store, modify, retrieve, and report on data in an IMAGE data base. Commands can be entered either from an interactive terminal or a batch input device such as a card reader.

**Applications:** Since QUERY is designed for the non-programmer, it can be employed in a variety of applications after only minimal training. Both novices and experienced programmers will find it extremely valuable. Some of the major application areas include:

- Casual Inquiry of the Data Base—facilitates searching a data base for information without writing a program or waiting for a periodic batch run.
  - On-line Data Updates—permits modification or deletion of data on-line directly from a terminal to the IMAGE data files.
  - Report Generation—formats reports with header and column labels, page numbers, and group labels.
  - Application Program Debugging— aids in program development. The user can manipulate data base information with a new program then test results through QUERY.
- Features:** In addition to the applications listed, QUERY performs several other valuable functions.
- Selection of Data Through Logical Comparisons—locates specific entries for processing based on logical criteria specified in a FIND command.
  - Creation and Storage of Procedures—stores frequently used or lengthy commands as individual procedures in a command file, avoiding the necessity of retyping them when needed.

- Display Data Base Structure—displays structural information about the data base and shows the relationship between data items and the data sets they are located within.

**Security Provisions:** QUERY adheres to all of the security provisions included in the IMAGE data base. After QUERY is invoked, a security level word must be entered. The word determines which data entries and data items may be accessed.

**Data Types:** Data placement in a data base is not limited to COBOL, RPG, BASIC, FORTRAN, and SPL. QUERY manipulates many of the various IMAGE data types. Each specific data type has a length ranging from 2 digits plus a sign to 132 characters. The types of data are:

- One-word integer numbers.
- Two-word integer numbers.
- Two-word real numbers.
- Four-word extended precision numbers.
- One-word logical values as absolute numbers.
- Zoned decimal numbers.
- Packed decimal numbers.
- ASCII character strings containing no lowercase alphabets.
- General ASCII character strings.
- One-word integer numbers corresponding to COBOL computational data.

- Two-word integer numbers corresponding to COBOL computational data.

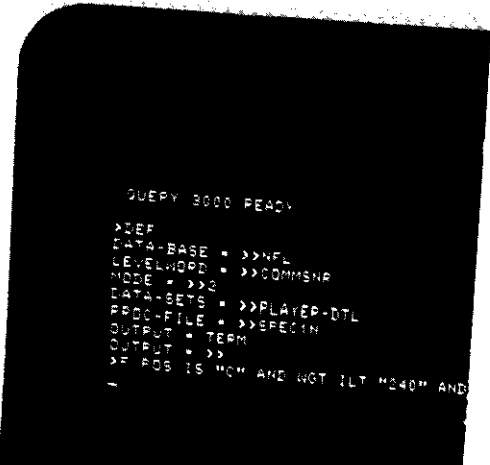
**Environment Commands:** A group of seven simple commands facilitates communication with QUERY to establish the operating environment. Data base, data set, procedure file, and output device are specified in response to prompts. Changes in the environment are effected by retyping the modified parameter.

**Inquiries:** The FIND command locates entries in a data base. Logical selection criteria, included in the command, allow only the entries pertaining to a given inquiry to be returned. Up to 50 logical relationships, specified in one command, locate up to 65,000 entries.

**Reporting:** Data entries can be displayed or reported according to a pre-specified format. After the data records have been located through the FIND command, a REPORT command is used to specify which items within those records QUERY is to display. REPORT also specifies such items as titles, column headings, page numbers, and line spacing.

**Updating:** A data base may be updated by adding, deleting, or modifying an entry through the UPDATE command, which operates within the limits established by the level word and access mode. QUERY prompts for the values needed to complete a transaction.

*Users easily modify, store, retrieve, or report on data in the IMAGE data base through the QUERY inquiry facility.*



**Data Sets:** There are two types of data sets in IMAGE—masters and details. Together they are used to create the application's logical data structure for the computer.

Master data sets can be either automatic or manual. Automatic masters contain only key values and pointer information, so they require a detail data set for information storage. Upon updating information stored in the detail, IMAGE will automatically update the appropriate logical pointers.

Manual masters not only contain keys and pointer information, but other related data as well, if desired. They can be self-contained (requiring no detail) or used in conjunction with a detail to form hierarchical data relationships. The user program maintains the file pointers upon the update or addition of a record.

Detail data sets are very similar to the files found in conventional file systems. They hold the information which is used by the master data sets to logically form the user data base.

Masters and details are interrelated in a complex data structure wherein each master can call 16 different details and

each detail can be called by 16 different masters. By structuring in this manner, data can be retrieved very rapidly.

IMAGE requires minimum operating overhead because much of the chaining and logically related information is left in the records. IMAGE data bases do not require dedicated disc volumes.

**Access Methods:** Interactive terminal or batch access to data is accomplished by means of applications programs using a set of library routines. Four methods of access available with IMAGE are serial, directed, calculated, and chained.

**SERIAL ACCESS:** In this basic access method, IMAGE starts at the most recently accessed record and sequentially examines successive records until the closest data entry, if any, is found. Retrieving the next greater-numbered entry is referred to as forward serial access, and retrieving the next lower-numbered entry is backward serial access.

**DIRECTED ACCESS:** With this second access method the calling program specifies the record address of the data entry from which the desired data items are to be retrieved.

**CALCULATED ACCESS:** For calculated access the retrieval of master data set entries is based on the entry's content. It is not necessary for the user to know where the desired entry is located within the data set. In this method the user supplies the value of a search item (or key), which IMAGE then uses as input to an address formula to calculate the record number of the desired entry.

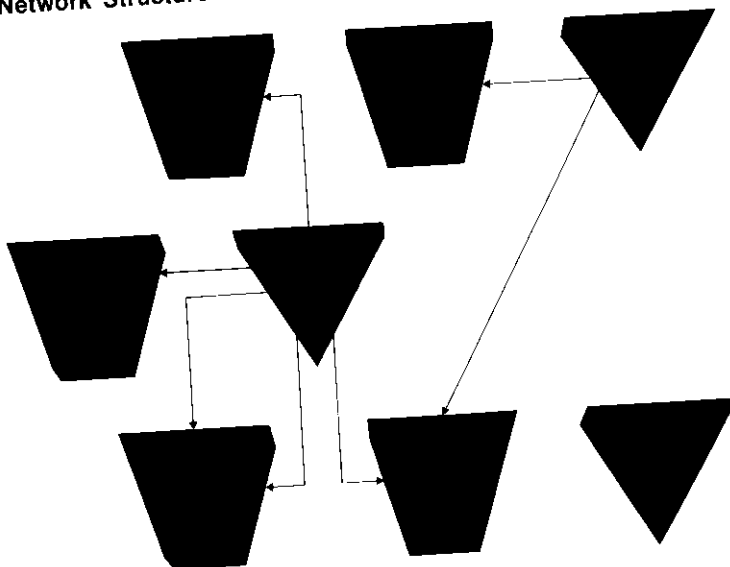
**CHAINED ACCESS:** Used with detail data sets for which search items have been defined, chained access is the successive retrieval of the data entries in a specified chain. IMAGE maintains and uses pointer information to directly locate members of a chain. Additions and deletions to chains are made by modifying bi-directional pairs of pointers in the data records. This modification is done automatically by IMAGE.

**External File System Protection:** All files of IMAGE data bases are privileged in the MPE II file system. Unprivileged access by process or file system commands is not allowed, thus preventing accidental or deliberate violations.

**Internal IMAGE Protection:** Within a data base the designer may define privacy and security levels on data sets (files) and data items (fields). "Privacy" refers to provisions which preclude unauthorized read access; "security" relates to provisions which prevent unauthorized write access.

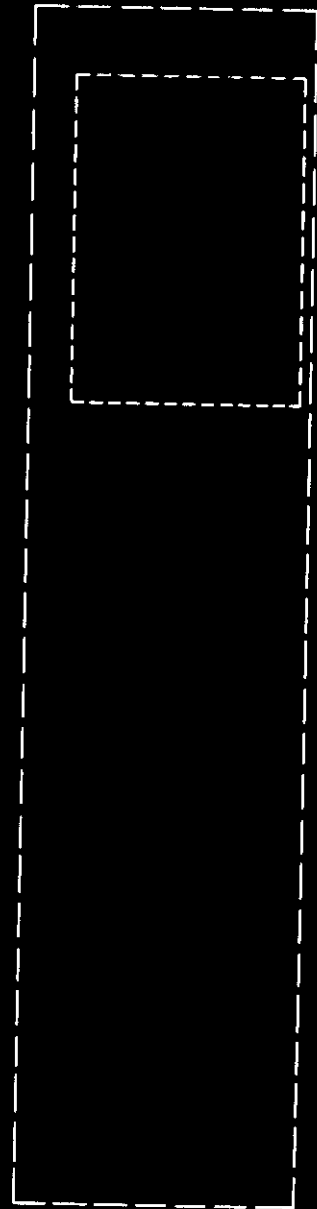
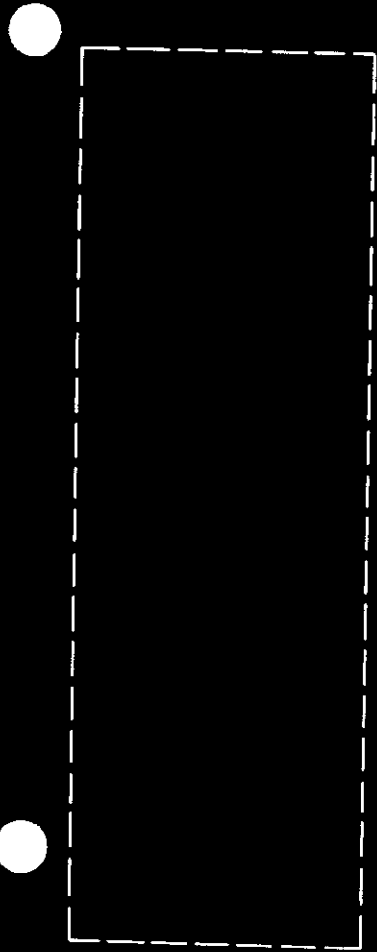
IMAGE contains a class-type privacy and security scheme wherein up to 63 classes of users can be defined. A password is associated with each class, and individual classes can be allowed read or read/write access to any or all data items and data sets regardless of the elements accessible to other user classes.

**Image Network Structure**





**Data Base Management**



# Data Processing in Five Languages

## Full programming capability

HP 3000 Series II Systems can be programmed in five languages (COBOL, RPG II, FORTRAN, BASIC and SPL) to satisfy the needs of every user. The various languages may be employed concurrently by several users, or one user may take advantage of several languages for a single application. Each of the languages, except the BASIC interpreter, is designed so the user invokes them in the same general manner. Since the HP 3000's subroutine call conventions are in microcode, programs in any of the languages can call subroutines from pre-existing programs written in COBOL, FORTRAN, BASIC (Compiler), or SPL. The availability of five languages means the user can work with the one most familiar to him or most suitable for the task.

**COBOL/3000:** Designed for commercial, business, and administrative applications, COBOL is a high level English-like language that is self-documenting and easy to learn. As are all high level languages, it is problem oriented and generally free of hardware constraints. Program statements utilize English phrases and sentences to simplify file descriptions, I/O, table handling, sorting, mass storage manipulation, and report generation. Fully integrated into the Multiprogramming Executive II, COBOL meets the highest-level 1968 ANSI ratings (except report writer module).

*Clear, concise software manuals are supplied with your system to aid in developing applications programs.*

**RPG/3000:** This high-level language makes it easy to generate almost any type of business report. The programmer specifies operations by writing simple entries on specially formatted coding sheets. Since RPG is a standard language on many computers, programs coded in other manufacturers' RPG II are accepted by RPG with little or no re-coding for conversion. Extensions to RPG II include parameters for subroutine calls, run-time error options, a cross-reference table, automatic program segmentation, EBCDIC-to-ASCII file translation, terminal I/O, and repeating condition code indicators.

**BASIC/3000:** In its original form, BASIC found most of its applications in educational and problem-solving environments. However, the introduction of a compiler along with string and file handling capabilities has made it applicable to business and industry as well. The simple constructs and format make it ideal for on-line programming at interactive terminals. Features such as character string manipulation, multiple data types, subroutines, multiple data files, matrix handling, and a trace-debug facility reinforce its usefulness in an interactive environment. A compiler is also available to convert source code into machine code. This process facilitates a fully interactive program development environment and permits production programs to run 10 to 30 times faster than the line-by-line interpreter.

Although BASIC was designed primarily for on-line use, the MPE file system adapts it for batch processing also.

**FORTRAN/3000:** Initially developed for scientific applications, FORTRAN is now widely used for business as well. In addition to meeting the ANSI standard (X3.9-1966), FORTRAN contains many extensions to enhance its power and versatility. It supports exceptional capabilities for character string manipulation. A new data type "CHARACTER" allows users to directly manipulate strings up to 255 characters long. Conversion of character expressions to numeric values and vice versa is dynamically facilitated by the INTRINSIC functions. And bit manipulation is conducted with partial word designators acting as unary operations. These operations extract or replace specific bit strings to form a new value of the same type. The file facility provides device independence and access to all file types.

**SPL/3000:** This ALGOL-like language was developed by Hewlett-Packard for writing systems software for the HP 3000 Series II Systems. It is particularly suited for the development of operating systems, supervisors, compilers, monitors, and subsystems, and for modifications or additions to existing Hewlett-Packard software. Combining the best features of both high level and machine-dependent programming languages, SPL allows the programmer to write software quickly and easily, while producing object programs with good code compression and efficient execution time. Features normally found in ALGOL or PL/1 programs, and also incorporated into SPL are:

- Free format structure.
- Arithmetic and logical expressions.
- High level statements with unlimited nesting.
- Recursive procedures and subroutines.
- Variable data, strings, and arrays of many data types.



## Utilities

### Efficient management of routine operations

To augment the capabilities of the operating system and language compilers, the HP 3000 Series II Systems include a set of utility programs. Through the Multiprogramming Executive II, these programs provide fast, efficient data transfers to: 1) set up production runs, 2) back up key data files, 3) manipulate source code, and 4) debug production programs.

**STORE/RESTORE:** Backup and restoration of key programs and data are critical to any production environment. MPE II provides a STORE command to allow file backup on any user selected bases. One file or the entire system can be off-loaded this way. Returning files to the system is similarly accomplished by a RESTORE command. Working in tandem, STORE and RESTORE aid in maintaining file integrity.

**EDIT/3000:** The HP 3000 text editor is used to create, manipulate, and store files of uppercase and lowercase ASCII alphanumerics. Lines, strings, and individual characters can be operated upon. Files may contain source language programs or text material such as reports. Interaction with EDIT is through a set of commands commonly used in the industry. Three unusual and powerful HP 3000 editor commands are USE, WHILE, and PROCEDURE. Defined command sequences can be stored in a file and executed by issuing a single use command. The WHILE command permits conditional execution of pre-defined command sequences. Special editing can be done by routines written by users in any supported language and executed through the PROCEDURE command.

**SORT/3000:** This utility consists of a sort program as well as user-callable procedures to order files in a specified sequence, and a merge program to combine several sorted files into a single output file. Each program supports contiguous, separate, and overlapping keys, handling all sequencing in one pass. Interactive sessions or batch jobs can use SORT and MERGE as a free standing subsystem through a few simple commands.

**FCOPY/3000:** Operating exclusively through the MPE file system, FCOPY performs all file copying tasks on HP 3000 systems. It can transfer files from any input device to any output device. An entire file or only selected portions may be copied. Other tasks performed by FCOPY include character code translation (BCDIC, EBCDIC, ASCII), verification of copy operations, new file creation, and file subset selection by pattern matching.



# Peripherals

## To enhance system capabilities now or later

In addition to the basic flexibility of the HP 3000's central processor, the key to the system's ability to adapt to changing requirements and grow as your application needs increase is the large selection of peripherals offered.

**Model 2640A CRT Terminal:** This low-cost terminal provides reliable computer communications and a smooth flow of visual information. The high data transmission rates and operational flexibility of the unit reduce on-line time and simplify computer communications. The CRT has a 5-inch by 10-inch display with a 1,920 character capacity in 24 lines of 80 characters each.

Other features of the terminal include plug-in character sets, multi-task keyboard, off-screen storage with scrolling capability, and inverse video for highlighting.

**Model 2644A Mini DataStation:** An interactive terminal, the 2644A offers numerous features to improve communication with the computer. It combines the benefits of the 2640A terminal with the advantages of two built-in mini cartridges for mass data storage. Up to 220 kilobytes of formatted ASCII or binary data can be stored. Many functions such as program preparation, data entry, editing, cartridge copying, and cartridge-to-print can be performed off-line to save computer time.

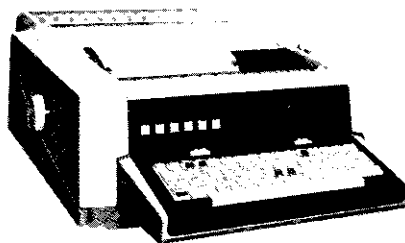
**Model 2762A Printer Terminal:** A medium speed terminal, this unit provides for direct or remote communication with the computer. It serves as the system console or as a terminal for the system. With an output speed of 30 characters per second, it enhances your system by making more effective use of computer time than would be possible with conventional terminals.

The terminal has a 75-column format, prints upper and lower case characters, and has a heavy duty mechanism for reliable, continuous operation.

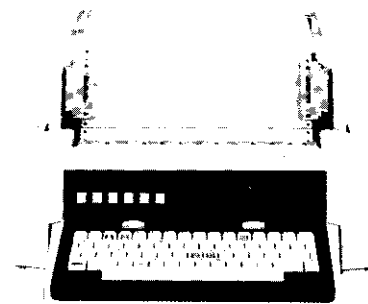
**Model 2762B Printer Terminal:** The high speed and 120 column format of the HP 2762B makes it useful for applications, such as long program listings and



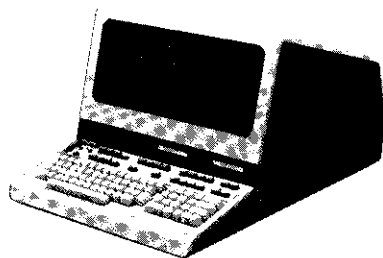
Model 2640A CRT terminal



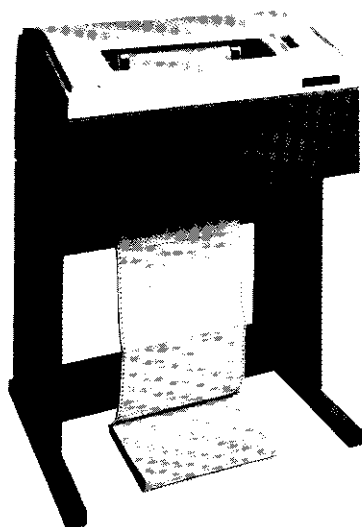
Model 2762A printer terminal



Model 2762B printer terminal

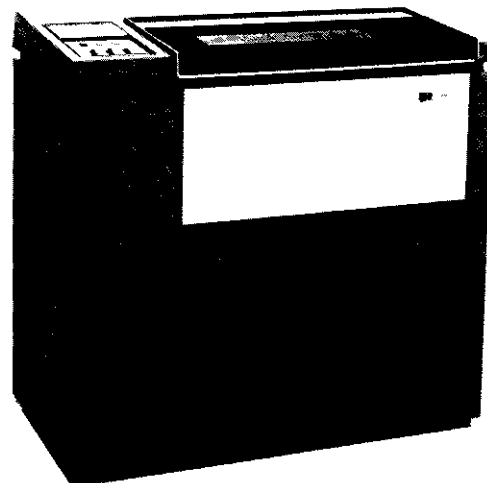


Model 2644A Mini DataStation



Model 30127A line printer

Line printers, CRT interactive terminals, and other peripherals can be added to any Series II configuration.



Model 30128A line printer



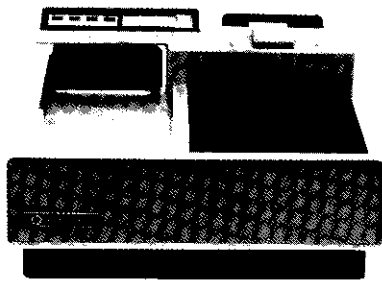
forms printing, previously not considered practical for low cost terminal devices. Switch selection of 10, 30, or 120 characters per second allows use of the terminal with applications having different speed requirements.

In addition to multiple speeds, other standard features offered by the terminal include a 94 upper and lower case character set, 120 column format, forms tractors for precise paper positioning, and a paper handler. The unit is designed for heavy duty use.

**Other Peripherals:** The terminals described above are complemented with the following peripherals.

#### CARD READER

Model 30106A— 80 columns, vacuum card pick, 600 CPM.



Model 30106A card reader

#### CARD READER/PUNCH

Model 30119A— 200 CPM reader, 75 CPM punch, 80 columns, dual input/output hopper.

#### DISC DRIVES

Model 30129A— 14.75 megabyte data disc with controller.

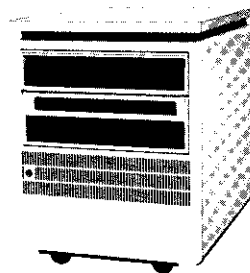
Model 30329A— 14.75 megabyte data disc without controller.

Model 30102A— 47 megabyte data disc with controller.

Model 30102A with option 010—

#### LINE PRINTERS

Model 30118A— 200 LPM, 132 columns, 64 or 128 character set, dot matrix line printer.



Model 30129A cartridge disc subsystem

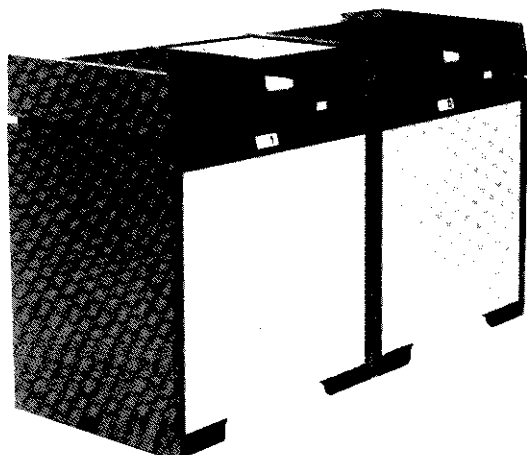
Model 30127A— 300 LPM, 136 columns, 64 or 96 character set, drum line printer.

Model 30133A— 600 LPM, 132 columns, 64 or 96 character set, drum line printer.

Model 30128A— 1250 LPM, 132 columns, 64 or 96 character set, drum line printer.

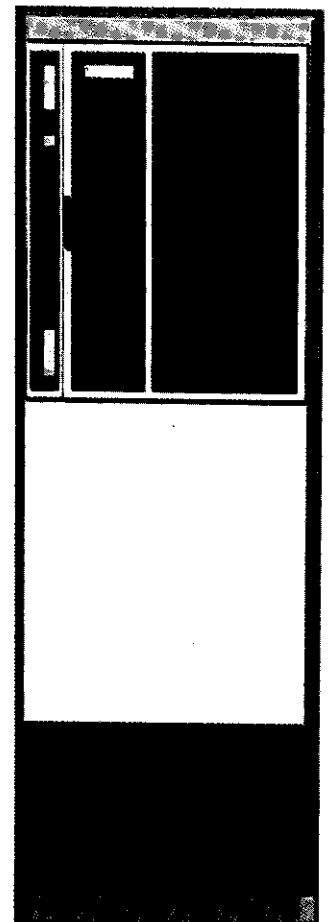
#### MAGNETIC TAPE DRIVES

Model 30115A— 9-track, 36K (800 cpi) or 72K (1600 cpi) character/sec transfer, 45 ips.



Model 30102A disc drives

Model 30115A magnetic tape drive



# Sales and Service Support

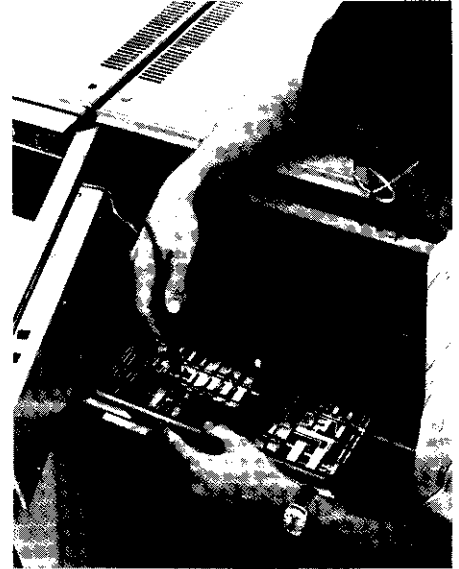
## **Sales Representatives and Systems**

**Engineers:** Your EDP requirements are analyzed by an experienced Hewlett-Packard team to help you determine the system most appropriate for your needs. Field representatives are backed up by the factory technical staff to make certain the system meets expectations.

**Customer Engineers:** Every HP 3000 system is installed by a service engineer and is warranted for 90 days, including service and preventive maintenance. Customer Engineers are supported by regional Product Specialists to further

insure the successful operation of your computer. A variety of long-term service contracts is available to maintain your system at reasonable cost.

**Full Training Support:** To assist your personnel in learning to utilize the HP 3000 fully, formal training courses are conducted at Hewlett-Packard training centers around the world. Alternatively, training may be conducted at your site by Hewlett-Packard Systems Engineers. Sessions encompass system management, software conversion, and software optimization techniques.



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Hewlett-Packard  
General Systems Division  
Marketing Dept.  
5303 Stevens Creek Blvd.  
Santa Clara, CA 95050  
Telephone (408) 249-7020

In Europe: Hewlett-Packard S.A.  
7, rue du Bois-du-Lan,  
P.O. Box CH-1217 Meyrin 2  
Geneva, Switzerland  
Tel: (022) 41 54 00

In Japan: Yokogawa-Hewlett-Packard  
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Shibuya-ku, Tokyo, 151  
Tel: 03-370-2281

In Canada: Hewlett-Packard Ltd.  
6877 Goreway Drive  
Mississauga, Ontario L4V 1L9  
Tel: (416) 678-9430

Other International Locations:  
Hewlett-Packard  
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Palo Alto, Calif. U.S.A. 94304  
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