digital

pdp8/e & pdp8/m small computer handbook

1972

digital equipment corporation

USERS THUMB INDEX

FOREWORD

Minicomputers, from Digital Equipment Corporation, are changing your world—in banks and hospitals, supermarkets and factories. Everywhere people are realizing that computers don't have to be large and expensive to get the job done. A Computer is no longer a multi-million dollar giant that can only survive in spotlessly clean rooms. Minicomputers are going where the job is, because they are rugged, dependable, and inexpensive.

You should know about minicomputers. The PDP-8/E Story shows our computers at work; designing, producing and testing new computers, saving time and money. Other industries, such as oil refineries and automobile manufacturers, are also using the power and speed of computers to produce better products. Minicomputers are not just for big business; hospitals, schools, laboratories and factories are using minis just as effectively. New and old companies are exploring minicomputers.

How large a computer should you buy? Most enterprises begin small. After the computer requirements are completely defined, a decision is then made to either continue with the existing system or to expand. The basic PDP-8/E can be expanded without having to sacrifice your initial investment.

Right now, there are more than 16,000 minicomputers serving in almost every field of endeavor and embracing every discipline known to man. The PDP-8/E and PDP-8/M are DEC's newest models of the PDP-8 family. We invite you to explore the advantages of owning this small machine with big ideas.

INTRODUCTION

This handbook is another in a series intended to familiarize the user with the Digital Equipment Corporation (DEC) PDP-8 family of small general-purpose computers. It explains the newest member of the family, the PDP-8/E Programmed Data Processor and how it is interfaced with the wide variety of peripheral equipment available.

Major topics are: The Programmed Data Processor, PDP-8/E Options, Interface & Installation, Support Services, and Appendices.

Another member of this series of handbooks is titled: An Introduction to Programming. The programming handbook familiarizes the user with the principles of programming the PDP-8 family of general-purpose computers. Together this handbook and the programming handbook describe the complete hardware and software aspects of the PDP-8 family. A newly released handbook called Programming Languages has been added to the handbook series which contains information on the primary languages for the PDP-8 family such as FOCAL, BASIC, PAL III, MACRO, PAL D, SABR, and 4K FORTRAN.

How to Use This Book

This book is neither a text book on computers nor a novel. It contains a wealth of information divided into specific areas of interest. For instance, Chapter 1 defines the basic processor and Chapter 3 defines the basic instructions. These two chapters offer information that allow the reader to compare a PDP-8/E with other processors.

A very important area to the reader who is buying a PDP-8/E is the extent of available, useable programs. Chapter 4 describes many of our commonly used programs, ranging from loaders to complete operating systems. Many more programs are further defined in Appendix A. However, these programs represent only a small fraction of the more than 1000 operating programs available to the PDP-8/E user.

Chapter 2 provides operating instructions. Because the operation of the processor requires similiar steps, learning to operate the processor can be compared with learning to drive a car.

To add additional capability (such as peripherals) Chapter 7 defines the complete line of options. Thousands of these options are presently operating in customer facilities.

For the customer requiring a special application, Chapters 9 and 10 illustrate in detail how a customer can design an interface to allow the PDP-8/E or the PDP-8/M to control his particular application.

The PDP-8/E Computer requires operating and programming skills.

Chapter 12 explains our courses of instruction designed to qualify customers in the areas of operation, maintenance, and programming. Chapter 12 also defines other various types of services including maintenance, depot level repair, software support, application support, etc.

THE COMPANY

In a little over thirteen years, Digital has become a major force in the electronics industry. The company has grown from three employees and 8,500 square feet of production floor space in a converted woolen mill in Maynard, Massachusetts, to an international corporation employing more than 6,000 people with well over two million square feet of floor space in more than 60 manufacturing, sales, and service facilities around the world. In addition to the corporate headquarters in Maynard, Massachusetts, other manufacturing facilities are located in Westfield and Westminster, Massachusetts. Internationally and outside the continental United States, Digital has manufacturing plants in England, Canada and Puerto Rico.

From its beginnings as a manufacturer of digital modules, the company has now grown to the point where it is the world's largest manufacturing supplier of logic modules and the third largest computer-manufacturer, by number of installations, in the industry. Digital's rise as a leader in the electronics industry began in 1957 with the introduction of the company's line of electronic circuit modules. These solid-state modules were used to build and test other manufacturers' computers. Two years later, Digital introduced its first computer, the PDP-1. The PDP-1 heralded a new concept for the industry—the small, on-line computer. And the PDP-1 was inexpensive—it sold for $120,000 while competitive machines with similar capabilities were selling at over $1 million. But the PDP-1 was more than a data processor; more than just a tool to manipulate data. It was a system that could be connected to all types of instrumentation and equipment for on-line, real-time monitoring control, and analysis. It was a system with which people and machines could interact.

Also, in 1958, Digital introduced the Systems Modules, high-quality, low-cost, solid-state, digital logic circuits on a single printed circuit card.

Today, electronic modules like the ones Digital introduced are used in most electronic equipment, from computers to television sets.

In 1965, Digital announced the first of the FLIP CHIP® module lines. These highly reliable modules include cards for internal computer logic, interfacing, control and analog-to-digital conversion.

In 1963, Digital Equipment Corporation introduced the PDP-5 computer, predecessor of the PDP-8 series. This was followed by the first PDP-8/I, and PDP-8/L. Over this seven year period, considerable improvement has been made, many options have been developed, over 60 peripherals and a variety of programs developed. As each new application need arises, Digital Equipment engineering responds with new equipment; each time further increasing the capability of the PDP-8 Family and making available a wider range of equipment.

Throughout the life span of the PDP-8 Family, DEC has developed more than 1,000 programs for a wide variety of applications. New programs are constantly in development by Digital's Programming Department and the PDP-8 Users. This means that each PDP-8/E user will have a wide variety of programs immediately available to him.

To further enhance the user's capability, the DECUS library contains a wide variety of programs developed by the PDP-8 users. This library is operated by DEC exclusively for customer use. Programs are available for as little as $1.00 each.

The PDP-8/E is designed for the inexperienced as well as the most sophisticated user. Digital Equipment Corporation provides training as well as maintenance.

PDP-8/E FEATURES

Digital's all new PDP-8/E is the most powerful, most expandable and most versatile 12-bit computer available today. Its low price and high performance makes it the ideal system for a variety of uses, extending all the way from minimal control units to fully expanded general purpose systems. It is fast, compact and easy to interface.

PDP-8/E offers features such as a unique internal bus system called OMNIBUS™, which allows the user to plug memory and processor options into any available slot location: the availability of 256 words of Read-Only or Read/Write memory; a 1.2 microsecond memory cycle time; the use of TTL integrated circuitry with MSI technology; expansion to 32,768 12-bit words of core storage; low-cost mass storage expansion with DECdisk or DECtape; and a space and money saving packaging design.

PDP-8/E Features at a Glance:

- A unique internal bus design called OMNIBUS which eliminates the need for back panel wiring. Processor options can be inserted in any available slot.
- Increased speed-memory cycle time of 1.2 microseconds.
- A new packaging scheme which makes PDP-8/E physically smaller than its predecessor, the PDP-8/I. And, with no predetermined locations needed for options, there is no wasted space in the logic panel.
- A full line of over 60 options and peripherals immediately available.
- More than 1000 programs immediately available to the user.
- Availability of 256 word increments of Read-Only memory and/or Read/Write memory.
- A Standard General Purpose register in the basic machine which becomes the MQ register when the EAE option is implemented.
- Six additional Processor IOT instructions which make flag manipulation and interrogation faster and easier.

- A six bit byte swap instruction allowing faster and more convenient character handling.
- TTL integrated circuit modules utilizing MSI technology.
- Over 11,000 compatible PDP-8 Family computers in use for sharing programs through Digital's users group, DECUS.
- Low-cost core memory expansion to 32,768 words and low-cost mass storage expansion with DECdisk, DECtape and IBM-compatible magnetic tape.
- Hardware Bootstrap Loader option.
- Provision for multiple (up to 17 total) teletypes.
- Worldwide, dependable service.
- Program and maintenance training included.
- Fully parallel processor.
- Link feature to facilitate multiple precision arithmetic.
- Full range of turnkey and applications-oriented systems available.
- Over seven years of software development by Digital.
- Expanded hardware multiply/divide.
- Eight auto-index registers.
- **FO**rmula **CA**lculator **L**anguage (FOCAL)
- **DI**gital Equipment Corporation **B**usiness **O**riented **L**anguage (DIBOL)
- FORTRAN
- BASIC
- Assemblers
- Editors
- Debugging Aids
- Operating Systems

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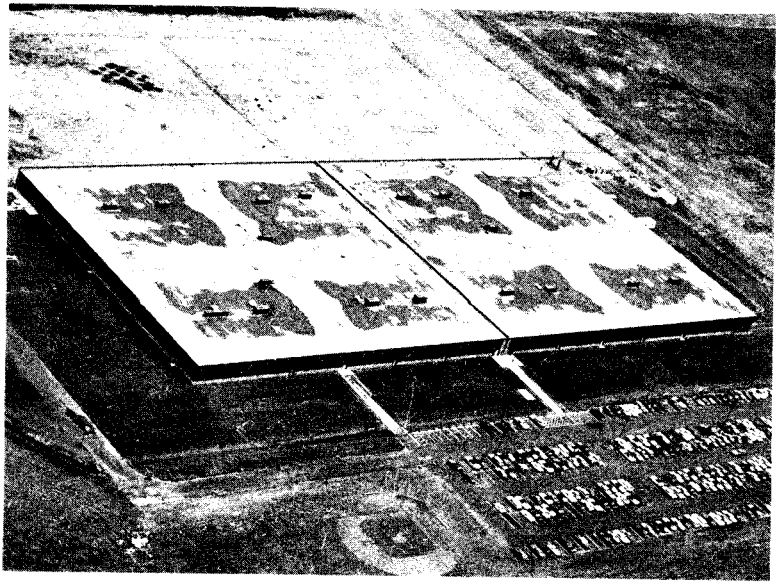
THE PDP-8/E STORY

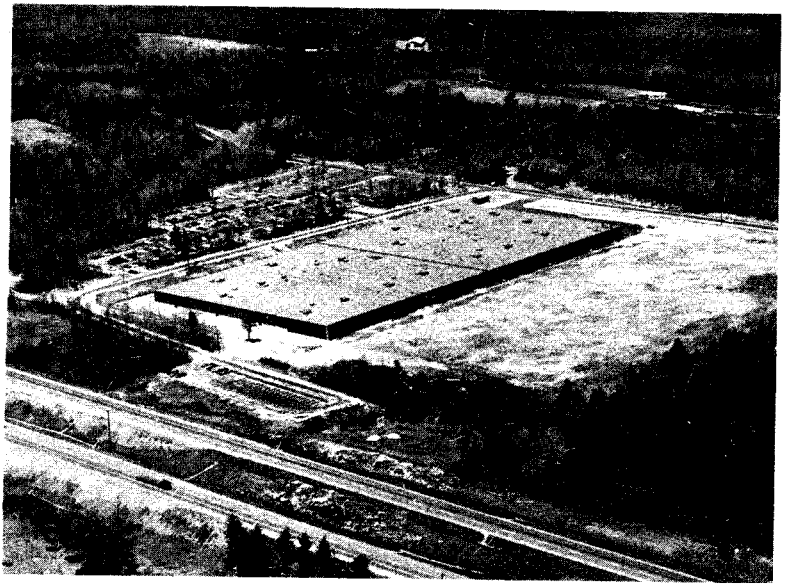
The PDP-8/E story is a guided tour, using pictures and descriptions, of Digital Equipment Corporation. We want you to see the skilled people, the manufacturing processes, the scores of test stations, and the wide variety of DEC products—all of which contribute to produce the finest, most cost effective computers and related products on the market.

At our production facilities in Maynard, Westminster, and Westfield, Massachusetts; Carlton Place, Ontario, Canada; San German, Puerto Rico; and Galway Bay, Ireland; computers are used extensively to design, produce and qualify new computers. After each computer has passed all of its qualifying tests and is accepted by DEC's quality control and field service groups, it is shipped with the full assurance and guarantee that the computer will provide the outstanding performance and dependability that our customers expect.

The home office and main manufacturing facilities for DEC, the third largest computer manufacturer in the world, are located in this mill complex in Maynard, Massachusetts. We have 1,000,000 square feet here, about 100 times more than when the company started producing digital modules 14 years ago.

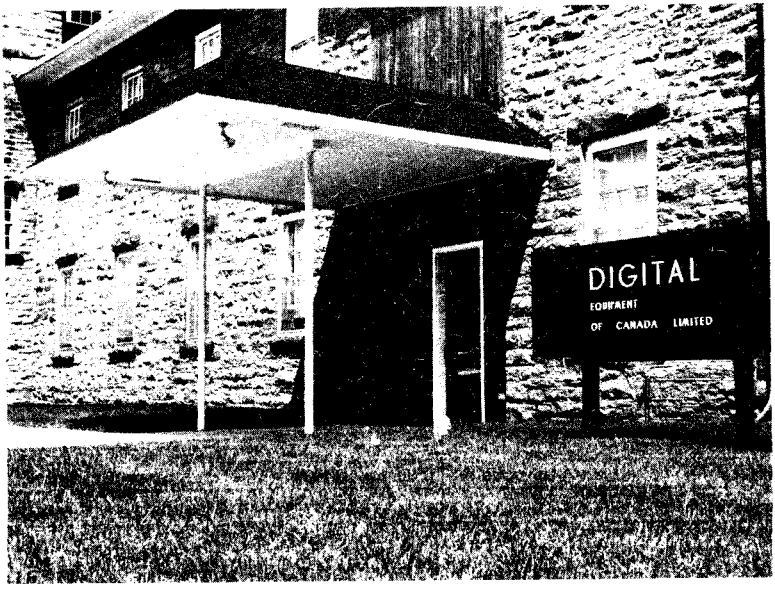


Westfield Plant — Westfield, Massachusetts, U.S.A.

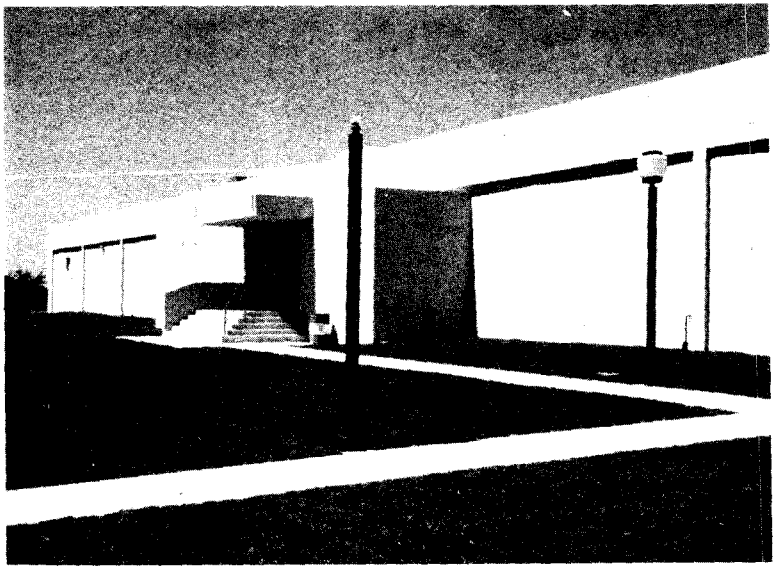


Westminster Plant — Westminster, Massachusetts, U.S.A.

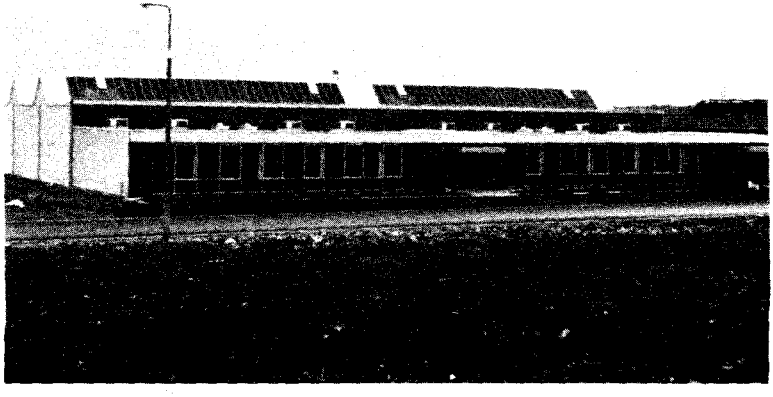
Mountainview, California



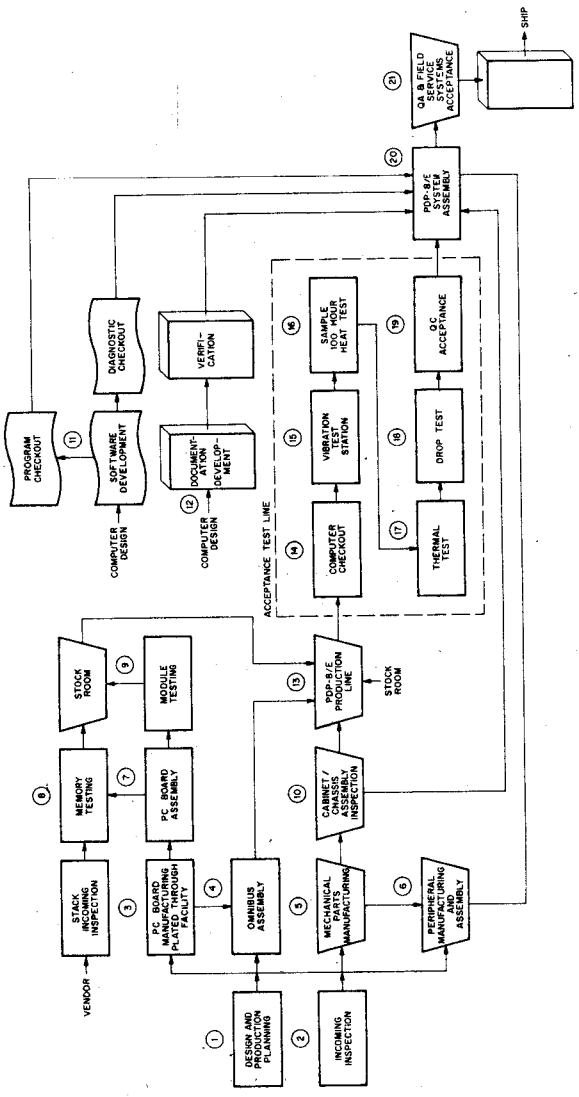
Carlton Place Plant — Carlton Place, Ontario, Canada



Galway Bay Plant — Galway Bay, Ireland

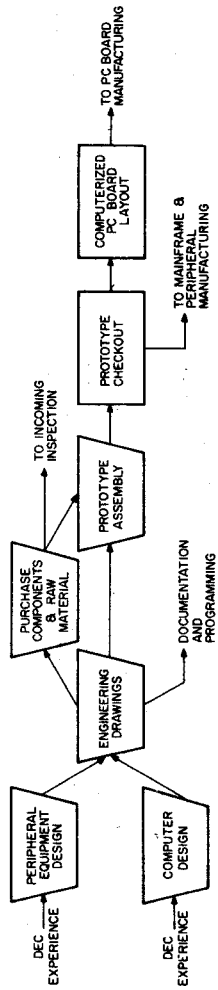


Puerto Rico Plant — San German, Puerto Rico



THE STORY

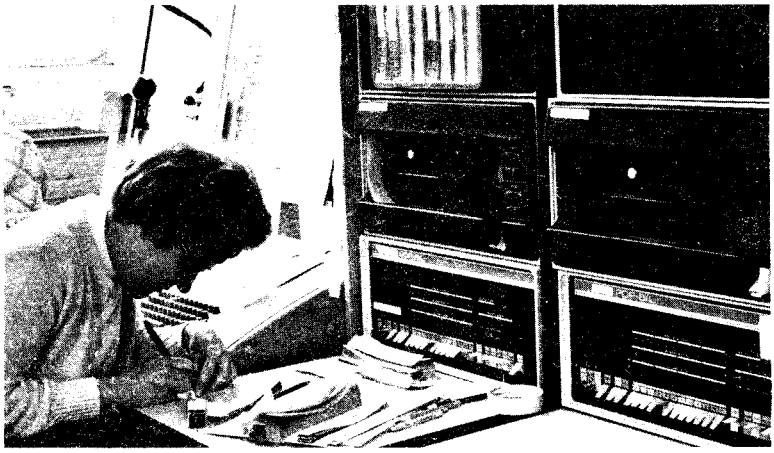
A diagram is provided for you to relate the photo-story to the actual events that occur here every day at DEC. It begins with design, evolves to incoming inspection of components and raw materials, then progresses to a finished computer system ready for shipment to a customer. The numbers in each block refer to the part of the story about that particular process or test.



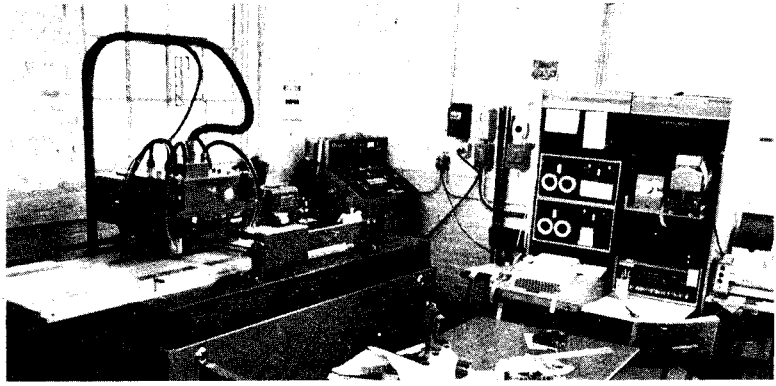
(1) Design and Production Planning

The experience that DEC has acquired from many years of computer and peripheral manufacturing goes into DEC's newest computers and peripherals. No equipment is manufactured until the prototype has undergone full evaluation by engineering, quality assurance, and field service.

After evaluation, production planning begins. New test stations to accommodate high volume testing are designed and produced. DEC's programming department immediately goes to work on new programs for all computerized testing.



DEC uses a PDP-8 Computer with a Digitizer to prepare for highly accurate automated drilling operations on PDP-8 logic module boards. Drilling coordinates are retrieved from a layout of a module (shown on the drating table). The information is stored in core memory, and the computer generates a paper tape that contains digitized information about the location of the holes to be drilled in the module boards.



The paper tape containing the digitized information is then taken to another PDP-8 computer for post processing to produce another paper tape with all of the various control signals to run the drilling machine. Thus, a PDP-8 Computer is actively involved in producing new PDP-8 Computers.

The X- and Y-coordinate information is first plotted out on an automatic plotter to check its accuracy and then post processed in the larger PDP-8 Computer. Next comes a test run on the drilling machine to see the results.

DEC uses computers to design more computers.

The PC board layout system (using a PDP-8 Computer, a KV Graphics System, and a Digitizer) is another example of computers being used to design more computers.

The computer is used to design and lay out each circuit board and obtain drilling coordinates.

The system provides the layout of a PC board from hand-drawn sketches by inputting X- and Y-coordinate information into the computer in digitized form. When the operator wants a connector to be placed at a particular location, he locates the digitizer cursor at the starting point and commands the computer via the Teletype®. The appropriate connector appears on the graphics display.

This information, in digitized form, is available to lay out the PC board, drill holes for the various components, operate the computerized component insertion machine, and other specialized functions. With this system, DEC is able to computerize a large part of the process of laying out and producing printed circuit boards.

® Teletype is a registered trademark of Teletype Corporation.

QUALITY

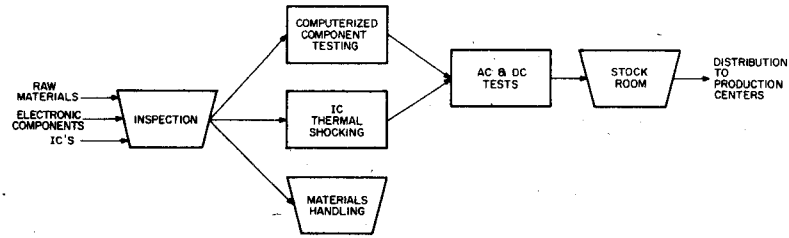
We have built more than 12,000 computers. Naturally, at DEC computerized testing techniques play a major role. Dynamic testing controlled by computers begins as each component is received at the plant and continues through most all production phases. As the major components of the computer progress through the assembly lines, the testing becomes more and more complex, and culminates with the final acceptance test of the finished system. Before a unit progresses to the next assembly or test station, it must meet the rigid standards imposed by DEC.

Computerized testing is ideal for quality control. Many similar tests are continually being run. By automating the tests, all results are calculated the same way and printed out in a standard format, thereby increasing test reliability and accuracy. The cost of quality control tests is drastically reduced by cutting manhours required for other test methods. The computer can control the tests, as well as acquire data and calculate results, and the system is flexible enough to make real-time "decisions" as the test progresses.

The advantages of using small computers during design, production, and testing are mainly economical. Small computers are inexpensive and can be located in the shop, right where the action is.

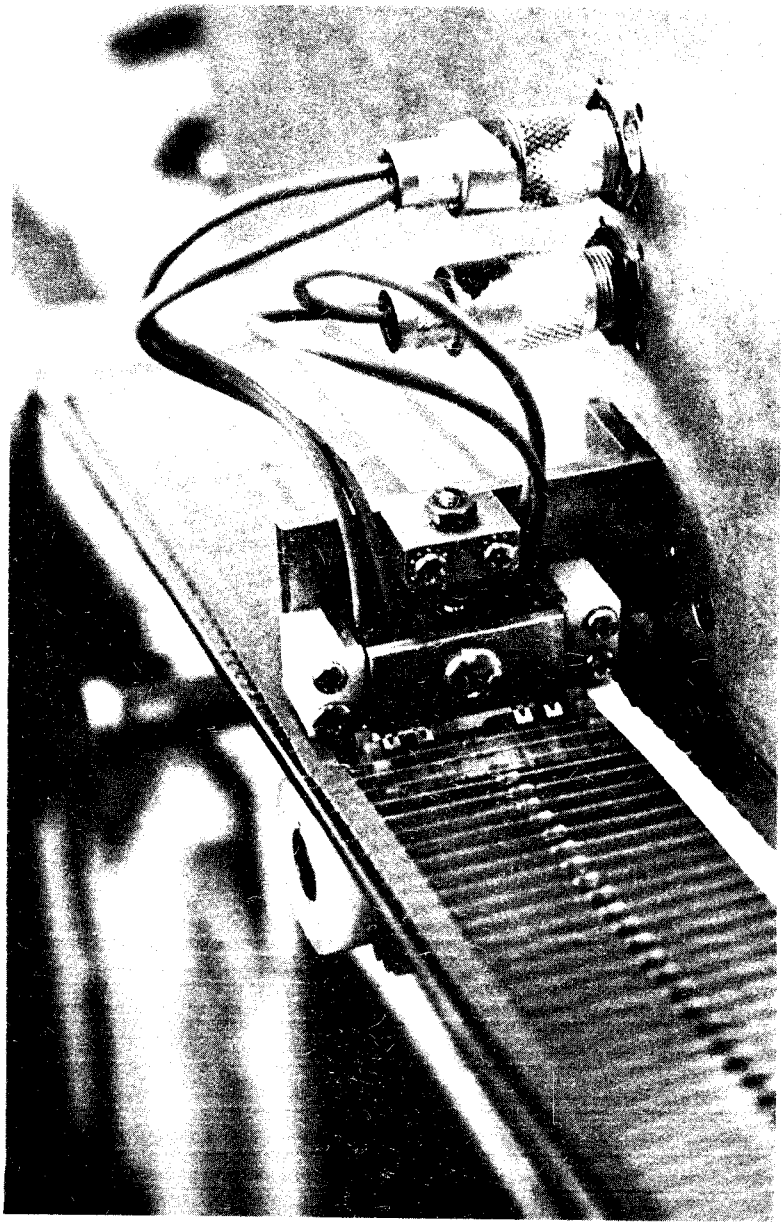
In manufacturing, computers provide on-the-spot testing. When repeatability of testing is important, computers make certain that all components meet the required standards. A computer can do the same task identically again and again; human variation in performing tests is virtually eliminated. The result is a test that is identical for each component being tested.

A written record of test results is often necessary. In computerized testing, the record is available the instant the test results are available. This is particularly important, especially on an assembly line where the unit must be qualified at one station before moving on to the next station. The test operator can press a button and instantly receive a printout of test results.

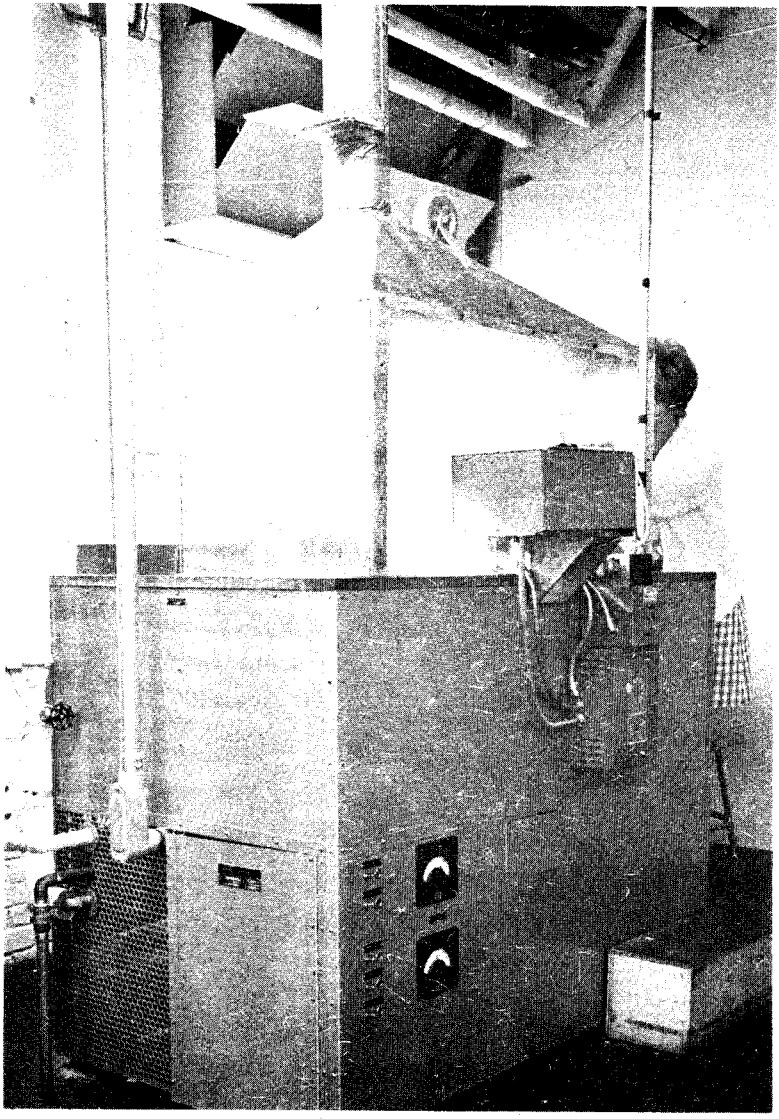


(2) *Incoming Inspection*

Inspection, testing and more testing, right from the beginning, is a major factor in the PDP-8 family success story. All material, components, and integrated circuits (ICs) must pass rigorous inspections before being placed in DEC's stock room.

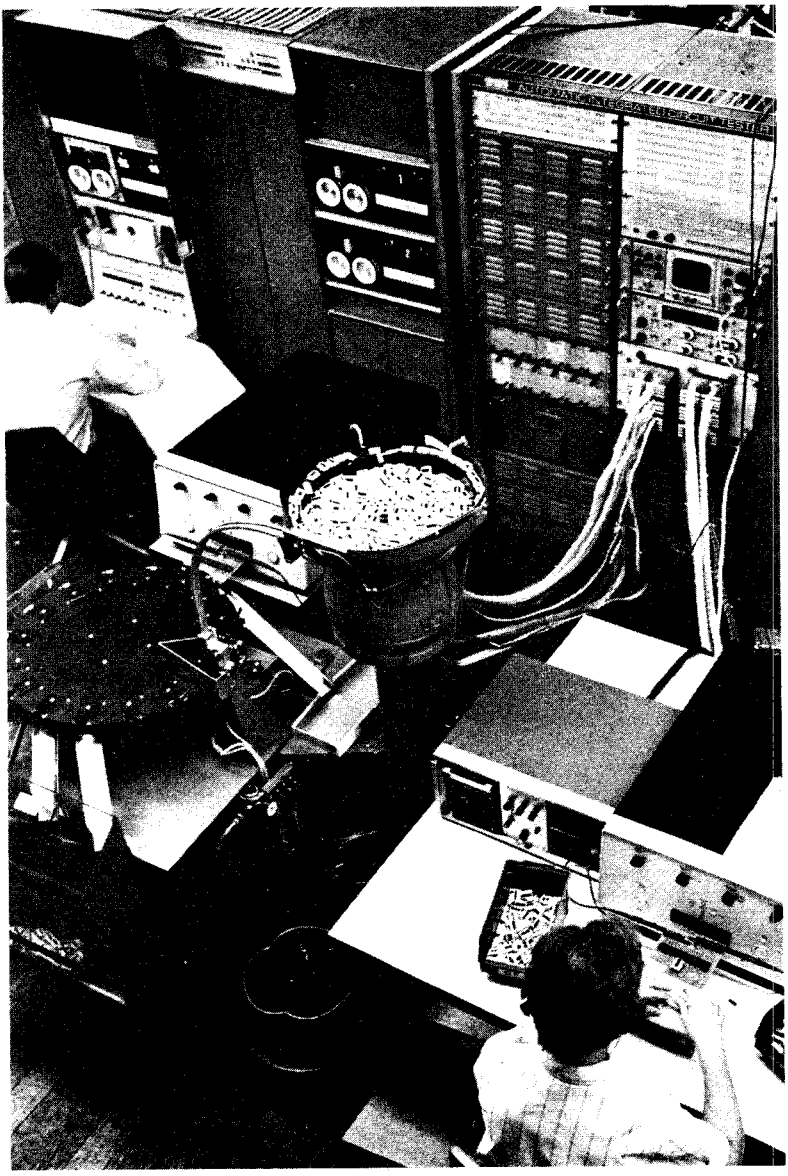


All incoming components are 100% tested. Here, diodes are being tested automatically.



All incoming IC's are tested—The IC Thermal Shocking Process

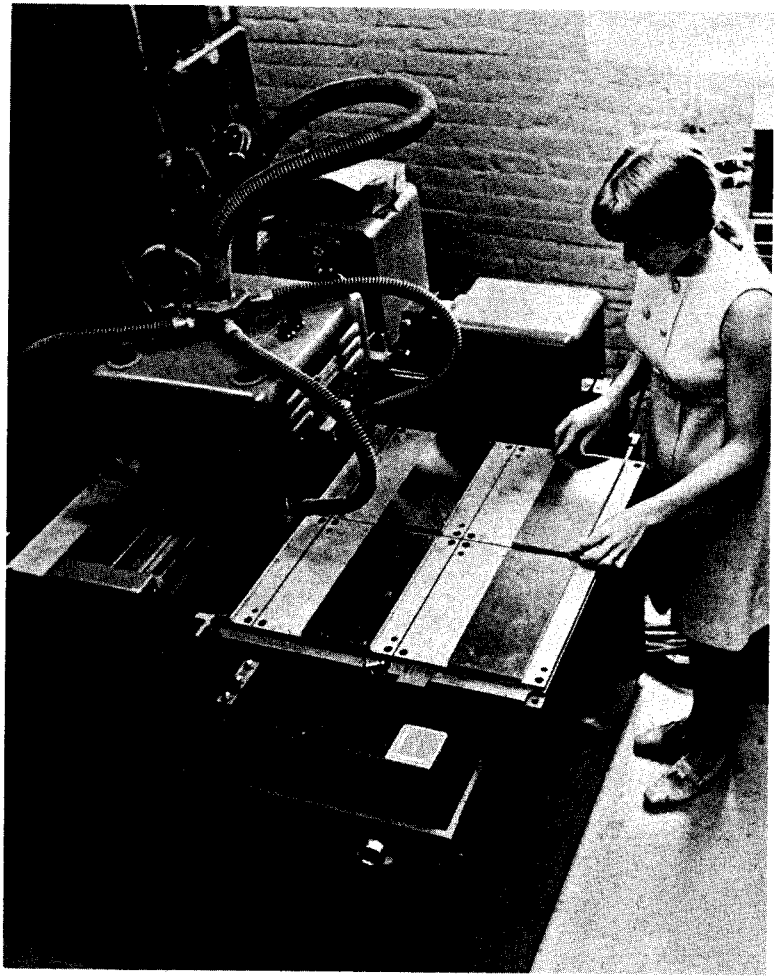
IC's are first given a cold test by placing the IC's into a bath at 32°F for 2 minutes. The IC's are then cycled into another chamber at a temperature of 212° F to force any possible fault to appear. Then testing for faults begins.



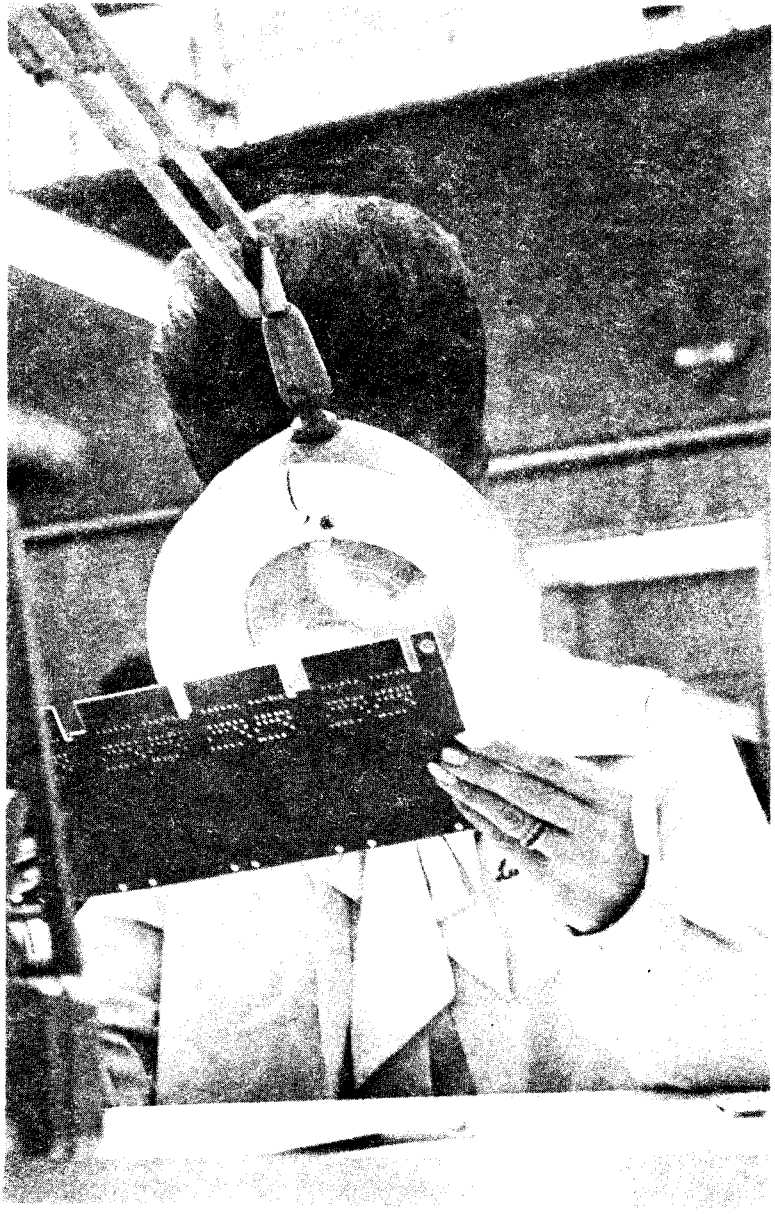
All incoming integrated circuits under computer controlled testing, with 40 dc and 16 ac tests performed in 1.1 seconds. This 100% inspection speeds production by minimizing the diagnosis of component failures in module test.

(3) PC Board Manufacturing Plated Through Facility

The manufacturing of printed circuit (PC) boards requires a facility that provides a controlled process and rigorous quality control. DEC is a world leader in the manufacturing of logic modules. We produce more than 3,000,000 modules per year and have been producing logic modules since 1957.

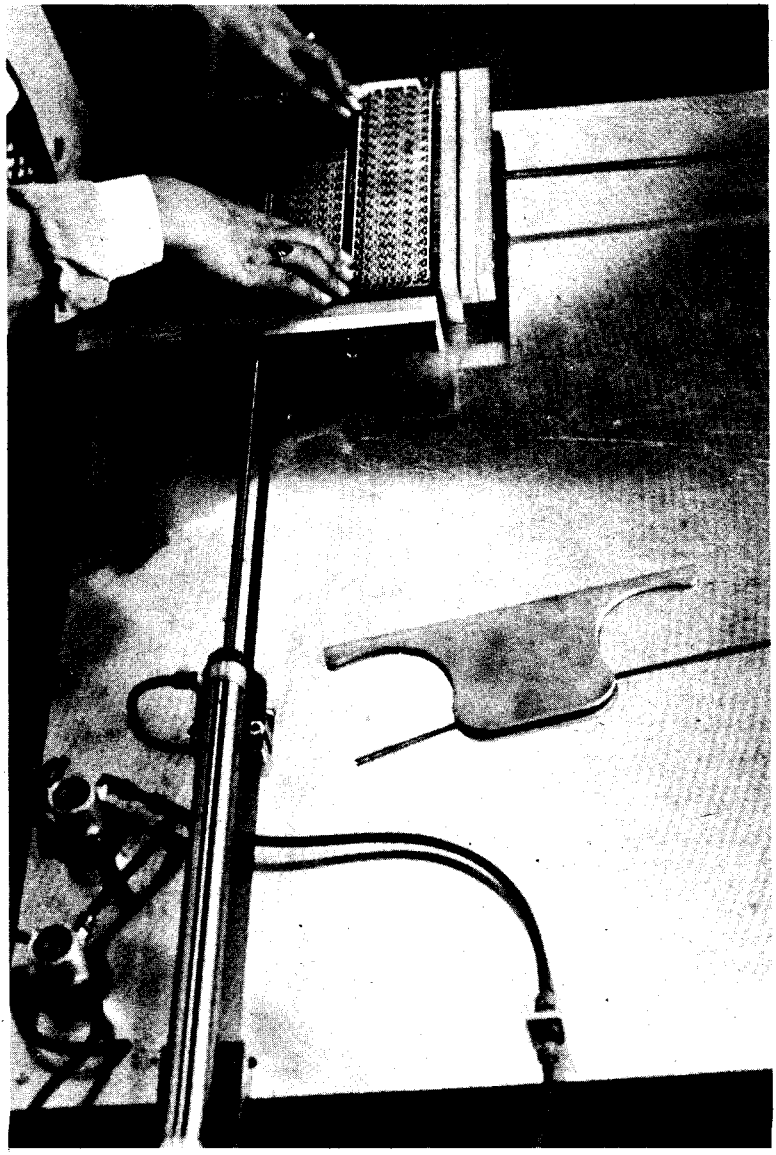


Twenty module boards are drilled simultaneously from a PDP-8 computer-generated coordinate tape. Other pantograph-controlled machines drill up to 200 boards simultaneously from a PDP-8 computer-generated template.



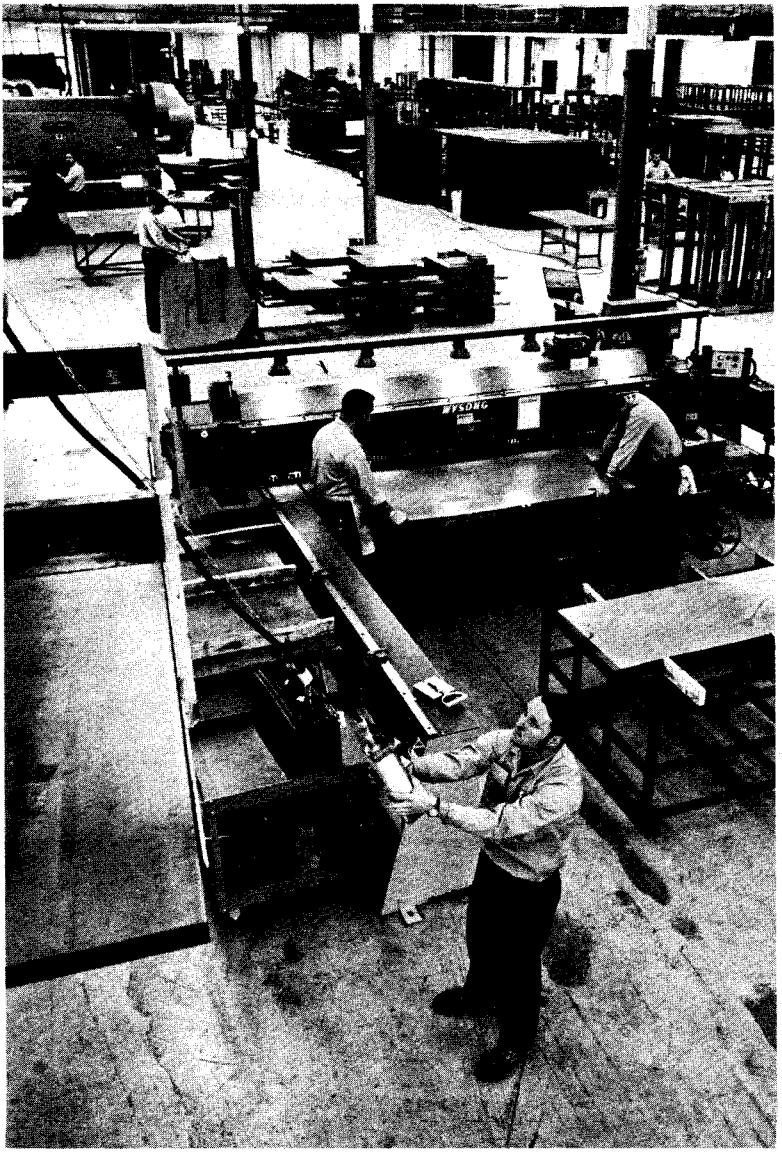
Quality of plated-thru holes is checked in our new electrochemical facility before boards go to the module assembly area.

(4) OMNIBUS Assembly



OMNIBUS Assembly—A PC Board and Connector Block are assembled here.

(5) Cabinet Assembly

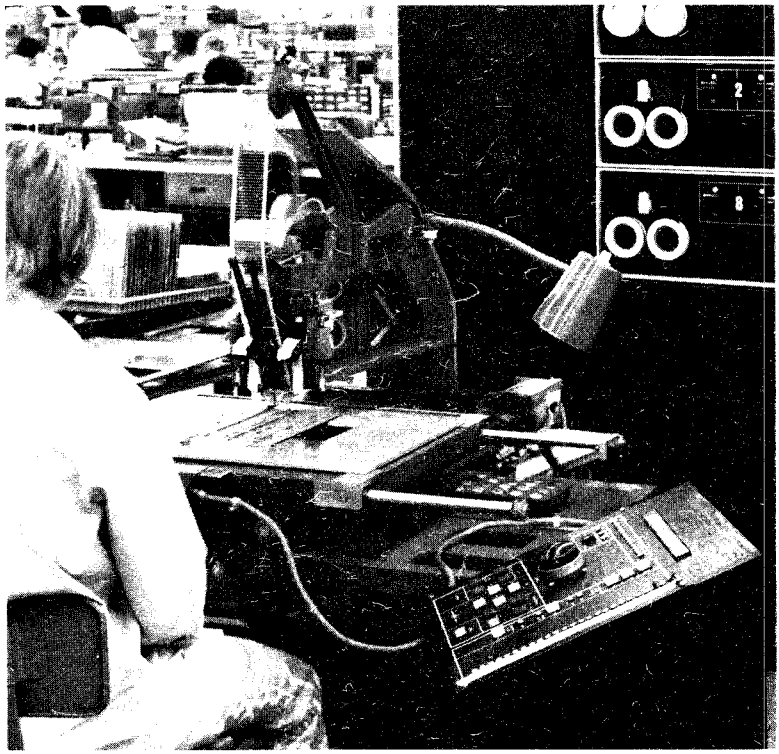


Cabinets for DEC systems are manufactured in this portion of DEC's Westfield, Massachusetts production facility.

(6) Peripheral Manufacturing
The blossoming of more peripheral assembly lines is a very real indication of DEC's continual expansion of products. At the DEC manufacturing plants shown above, just such an assembly line is producing the famous DECtape. Each component is given the usual controlled inspection procedure. Modules, which are used to control the operation of each DECtape, are produced in DEC's automated module assembly area. Quality control is the highest prority item. A series of severe tests and checks are run on all products.

(7) PC Board Assembly

The PC Board Assembly includes inserting components, soldering component leads and gold plating all printed circuit connectors.

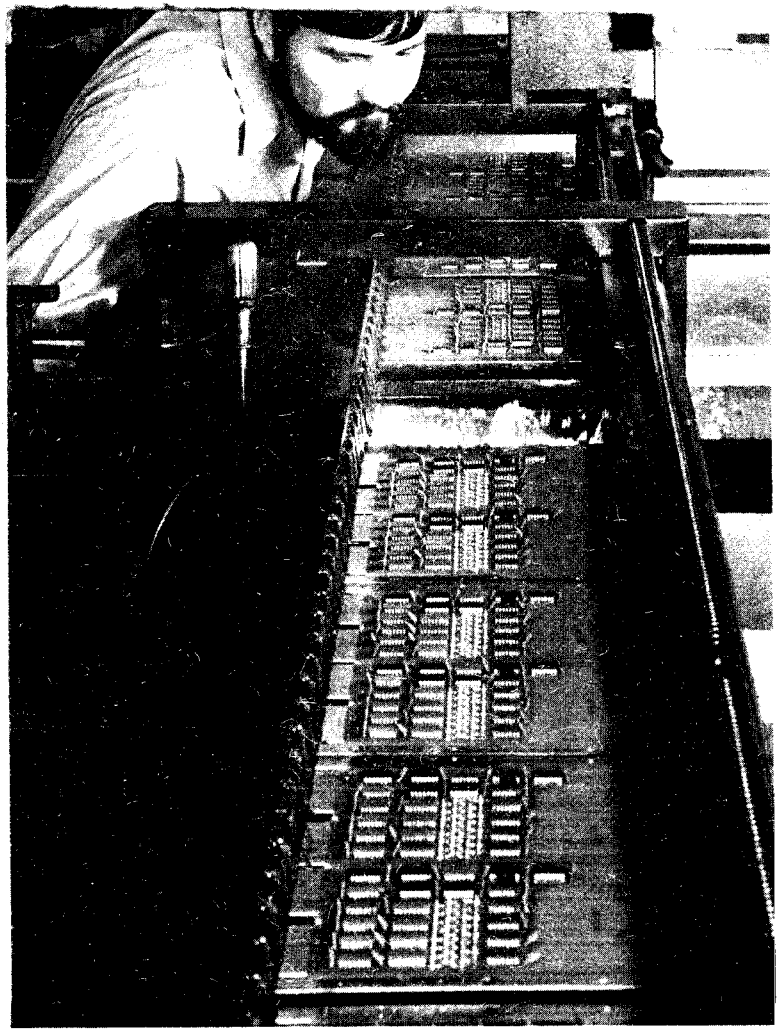


Component Insertion Machine

DEC designed and built a multistation component-insertion system to insert diodes, resistors, and capacitors into PC boards. Eight stations are controlled by one PDP-8 Computer. Each station contains a component-insertion machine with table driven stepping motors directly coupled to a rotary incremental-optical encoder.

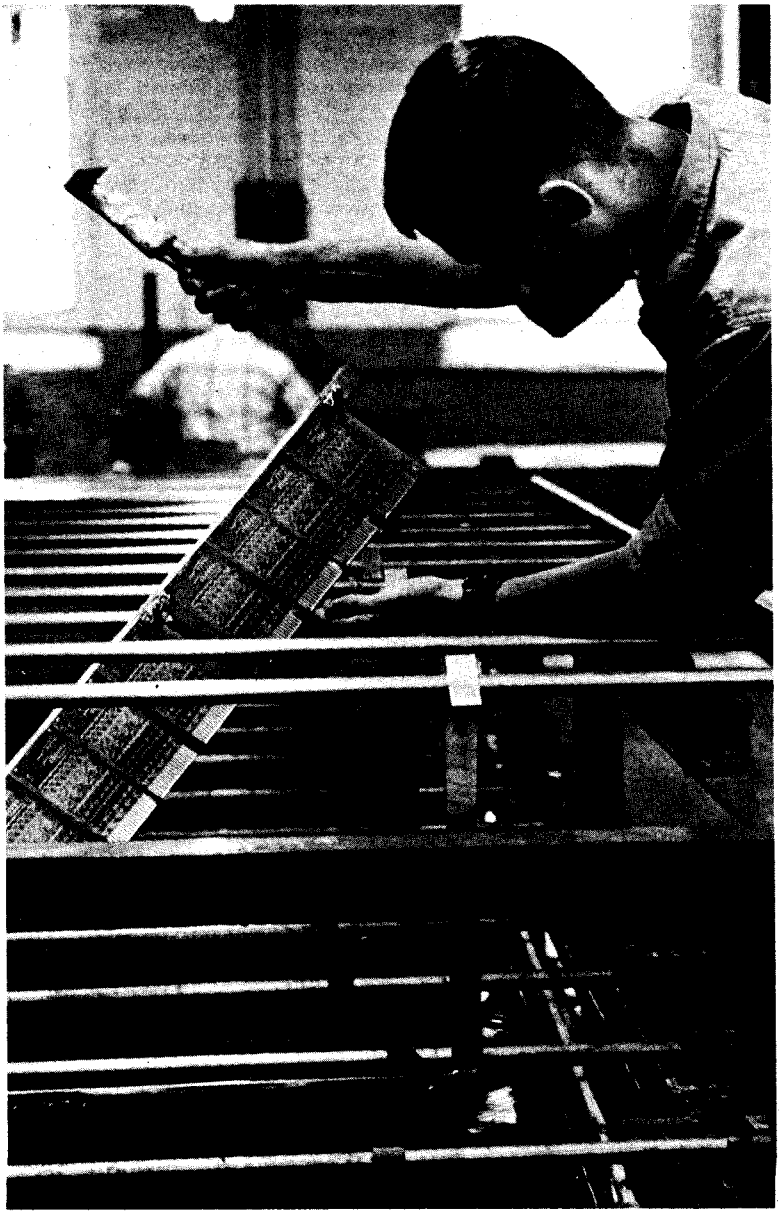
An X-Y table holding a batch of printed circuit boards is stepped back and forth under a stapling mechanism that inserts electronic components into predrilled holes on the boards at high rates.

The PDP-8 System uses a magnetic tape deck containing a library for PC-board parts lists. Each station has a custom-built control panel that permits the operator to start, stop, back up, go forward, jog-in offsets, and select parts from lists. The electronic parts are loaded into the insertion machines in paper-taped belts on large reels.



This flow-soldering machine solders all component leads to the board and makes all solder runs in one fast, exceedingly reliable, operation. More than 1000 modules are soldered on this assembly line each day.

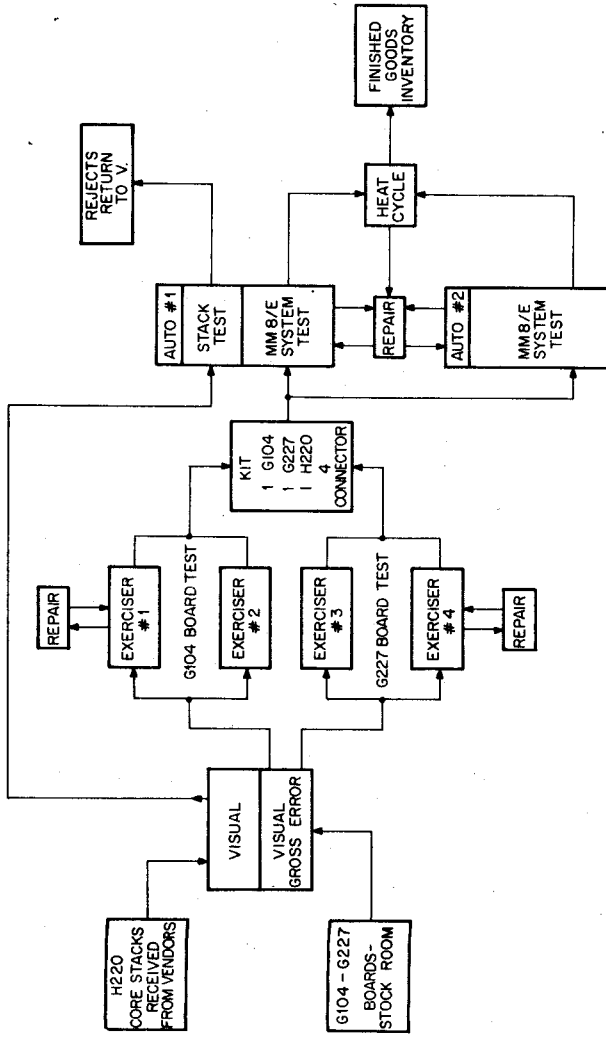
DEC has more than 2 million square feet of manufacturing space. This view shows a portion of a module assembly area.



Checking the appearance of board contacts being gold-plated. Our 100 micro-inch plating is verified by periodic checking on a radiation gauge.

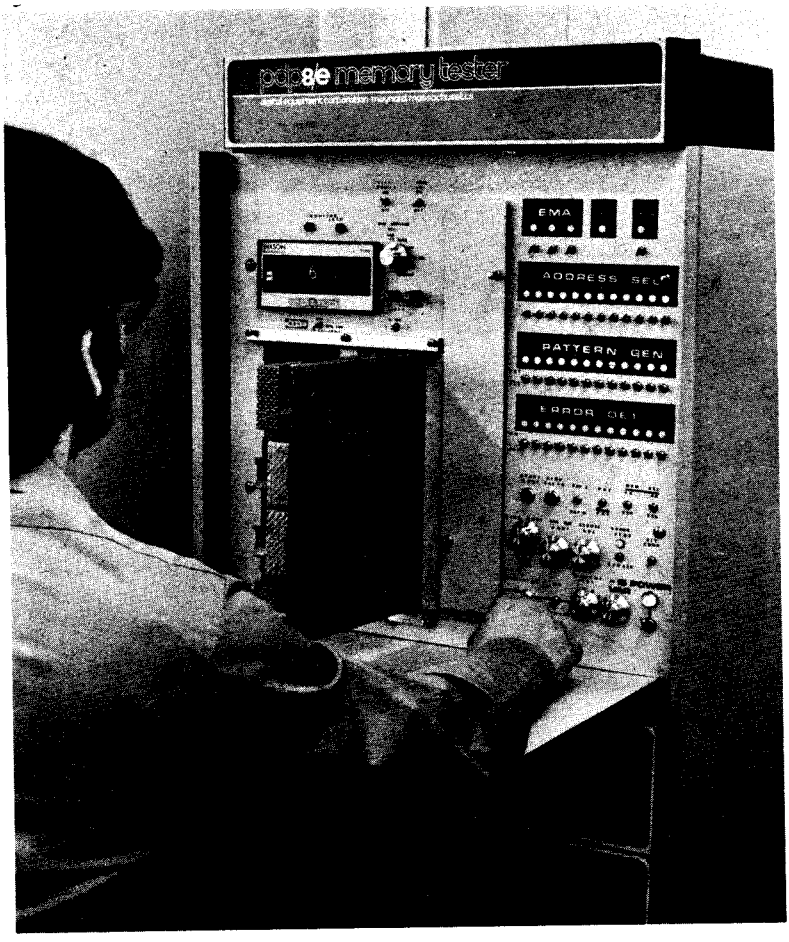
(8) Computers Test Memory Systems

Computers perform three complex testing operations on each memory system before it is approved by quality control. Each module is visually inspected and taken to a manual memory exerciser, qualified, and placed with other modules where a memory system kit is assembled. A complete memory system test is performed, and the assembled memory system is qualified. A final test is performed with diagnostic programs, exercising the memory system at its highest specified temperature limits in a heat chamber. Refer to MM8-E flow of inspection and testing.



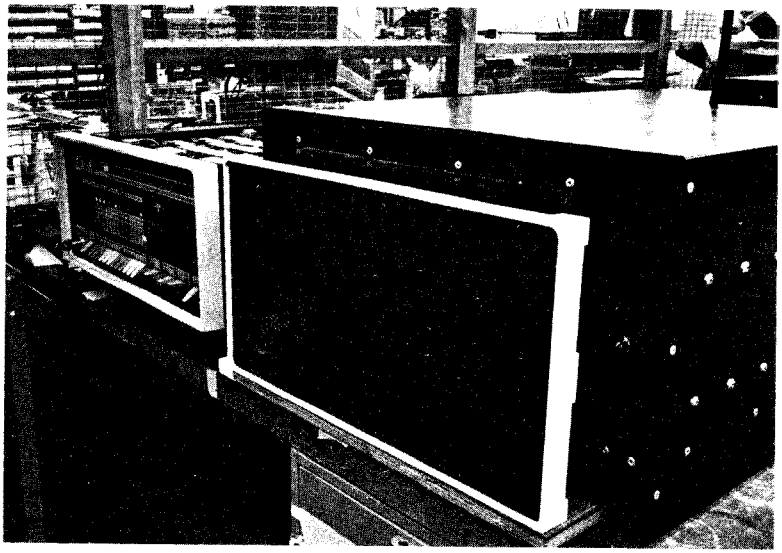
Memory Test Line

Qualifying PDP-8/E memory modules is accomplished by this test line. Every component in the memory modules are subject to thorough testing under a variety of conditions.



The PDP-8 Computer performs the dynamic testing of the memory units (MM8-E's—3-card ensemble). After each memory system kit has been assembled, the kit is tested at DEC's fully automatic station (AUTO #1 or AUTO #2) where typical operations of system characteristics are run to reflect normal operating frequency used by the computer. The tester varies the voltages and currents within the memory system upper and lower limits to ensure that the memory system meets the requirements of the specification. For each parameter tested, corresponding Schmoo-type curves are obtained. The total test time requires only 5 minutes for each memory system tested.

Again, a PDP-8 Computer is working to qualify new PDP-8 Computers. This automated testing technique allows no variation in quality; *no marginal units survive these tests.*



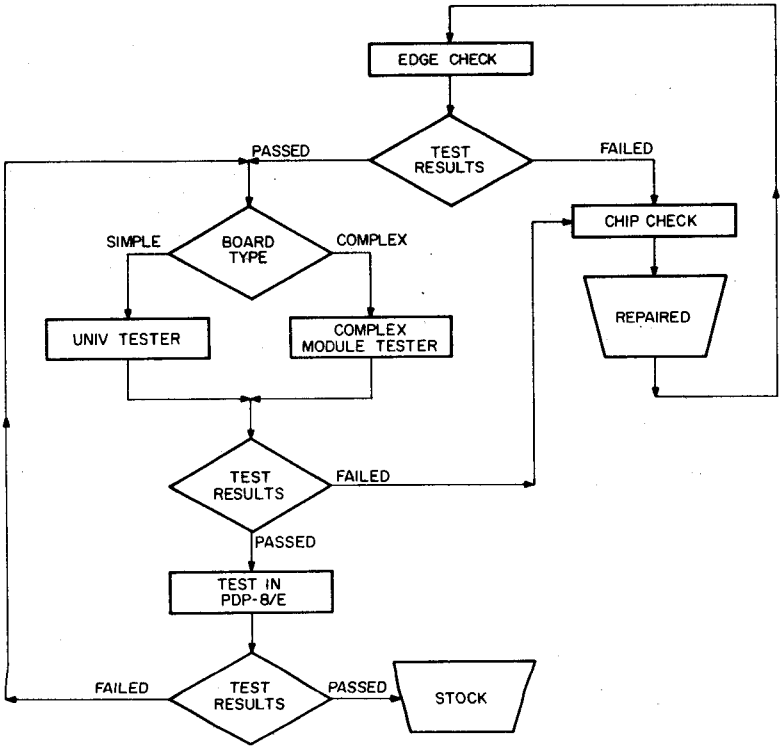
Memory System Heat Test

A final system test is performed by running memory diagnostic programs while the system is operating under maximum allowable temperature. The memory modules are installed in a heating chamber and connected to a PDP-8 Computer. If a fault occurs, a teleprinter connected to the computer prints out the type of fault; if the memory system performs flawlessly, the teleprinter prints a verification.

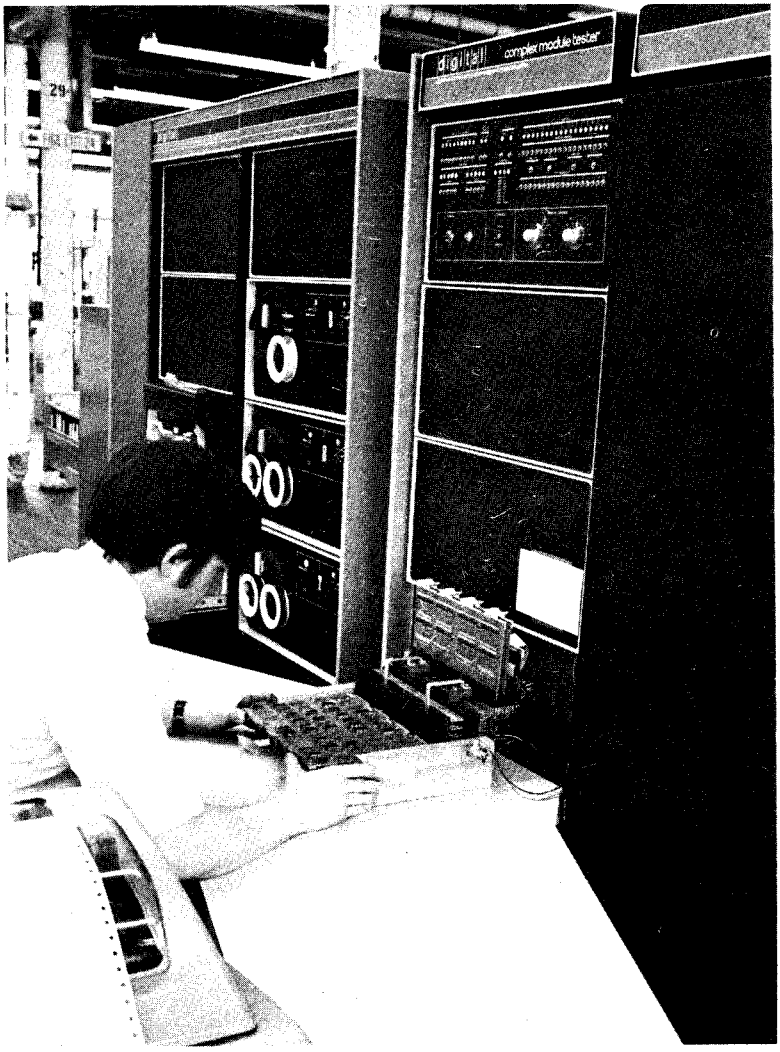
(9) Computers Test Logic Modules

A series of computerized tests are performed on all logic modules to maintain DEC's highest standards and ensure long life. Computers using diagnostic programs exercise and test every component on every module before a module is qualified for customer use. Hundreds of repetitive tests are performed in seconds as the computer evaluates every parameter, including maximum and minimum allowable current, frequency, and other important values. If a fault occurs, a teleprinter signals the operator; otherwise, the teleprinter verifies that the unit "passed the tests."

A detailed diagram of module testing is provided below, from the least complicated test to the most complicated test. Computerized testing begins with the edge check, which qualifies all of the circuit paths. If the module is simple, it is routed to the universal tester; otherwise, the module is qualified by the complex module tester. Any time a component failure is detected, a "chip" test is run to locate and replace the failed component. Each accepted module is then tested in a PDP-8/E System and qualified by a series of diagnostic programs that thoroughly exercise every component on the module.

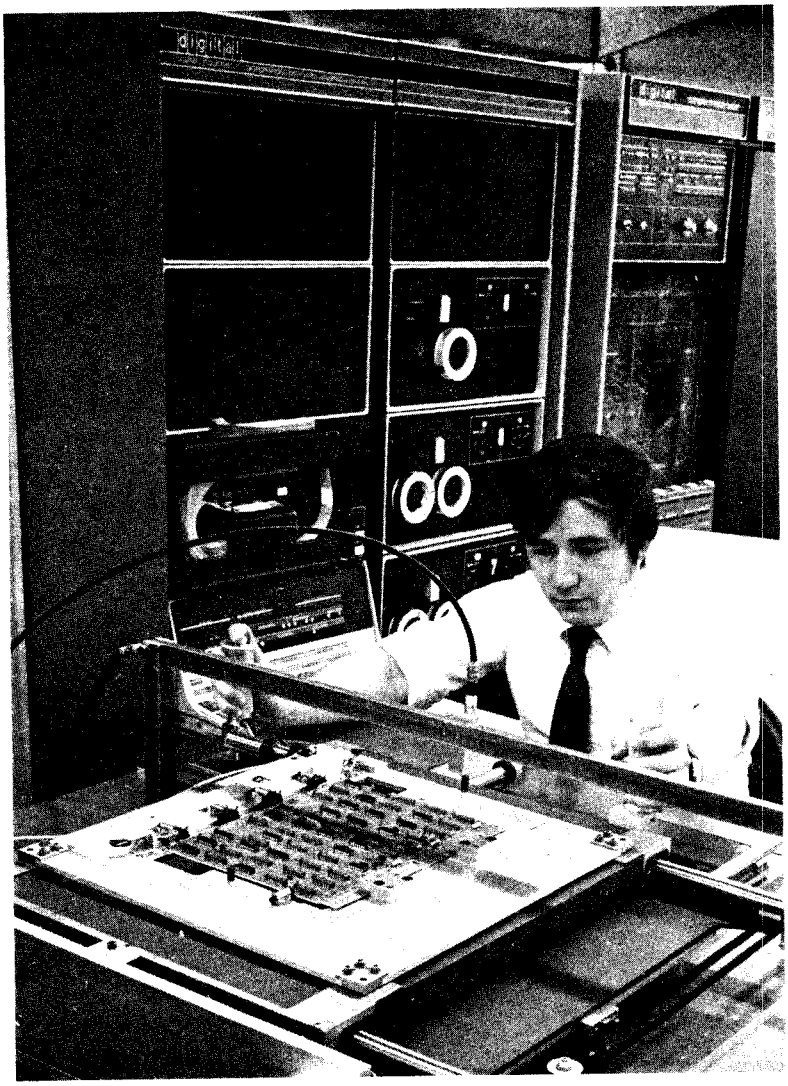


Module Computerized Tests Flow Diagram

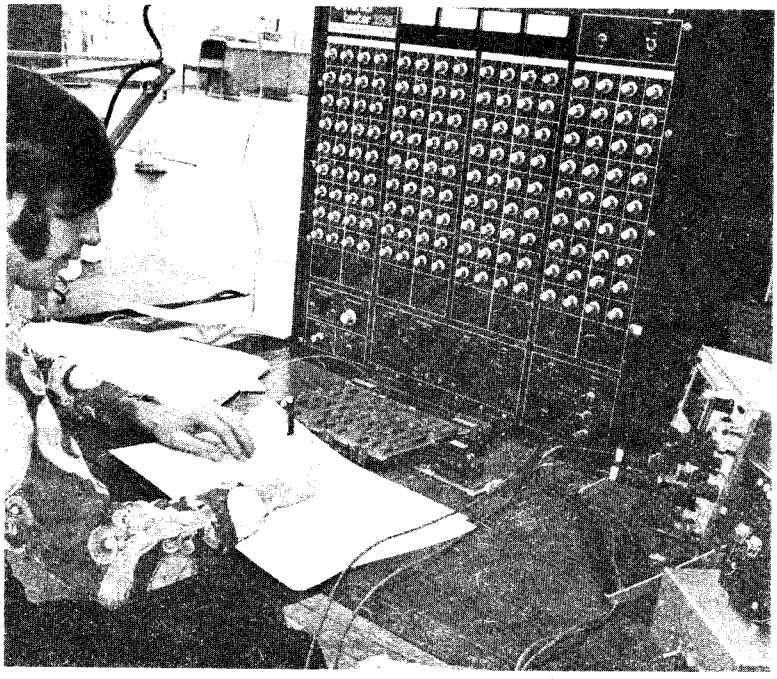


Module Computerized Tests

Complex Module Tester—The Complex Module Tester uses a Computer. The operator inserts the circuit board into a connector block and the computer applies the correct inputs and checks the correct outputs from that circuit board to verify its operation. If the circuit board is rejected here, it is passed to another test center where a technician uses the Universal Tester to further diagnose the fault.



Chip-Checker—The chip-checker tests individual IC's while mounted on a module board. This unit indexes in X and Y around a circuit board with a special probe that connects to and and checks out each integrated circuit on the circuit board. The computer in the background stores the programs for both testing and indexing the tester. DEC tests the integrated circuits (IC's) before being assembled on a circuit board by the incoming inspection method and tests once again after the IC's are assembled on a board.



Universal Tester or Logic Analyzer—This unit is the tester especially developed for PDP-8/E modules. Using this sensitive tester, a technician can isolate faults on any circuit card used in the PDP-8/E Computer. Through the various controls on the tester, the technician sets up all the various inputs that a circuit board uses. Then, with an oscilloscope he can monitor the output at various pins to verify the operation of circuit paths.

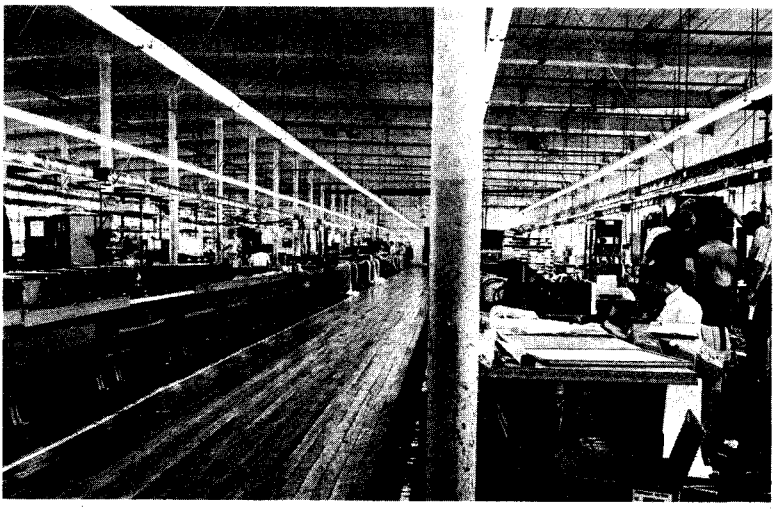
(11) Software Development

We develop new PDP-8/E software every day. Each new program is exhaustively tested on a PDP-8/E Computer before it is released for customer use. In addition to programs developed for customer use, DEC has developed a special series of diagnostic tests that are used by the various test stations.

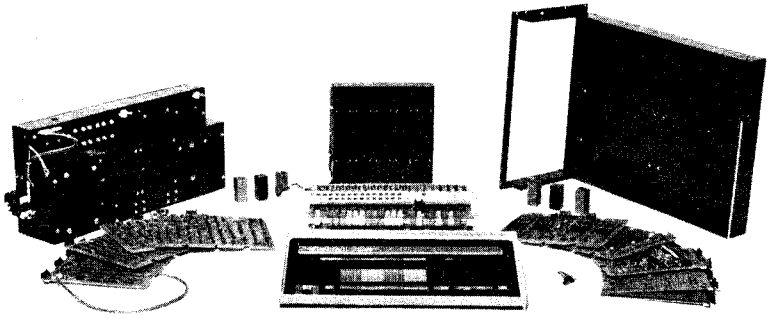
(12) Documentation Development

The explosion in computer technology demands the continual development of new computers and peripheral devices. In turn, continuing education for the people who use computers is absolutely necessary. DEC responds to this need for easily assimilated, accurate information by verifying PDP-8/E documentation with both engineering and programming. Our customers are equipped with up-to-date drawings, operating procedures, theory of operation, maintenance procedures, and programming instruction manuals.

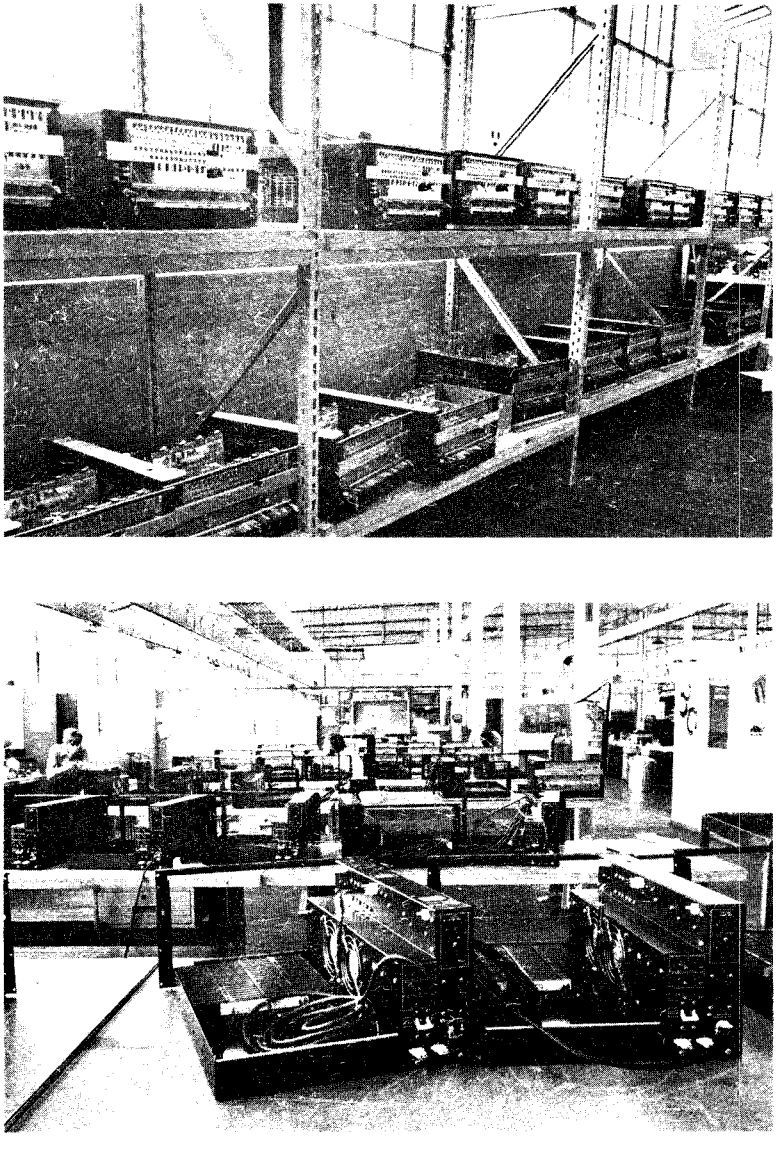
(13) The PDP-8/E Production Line



The PDP-8/E production line has the capability of manufacturing 1,000 PDP-8/E Computers per month.

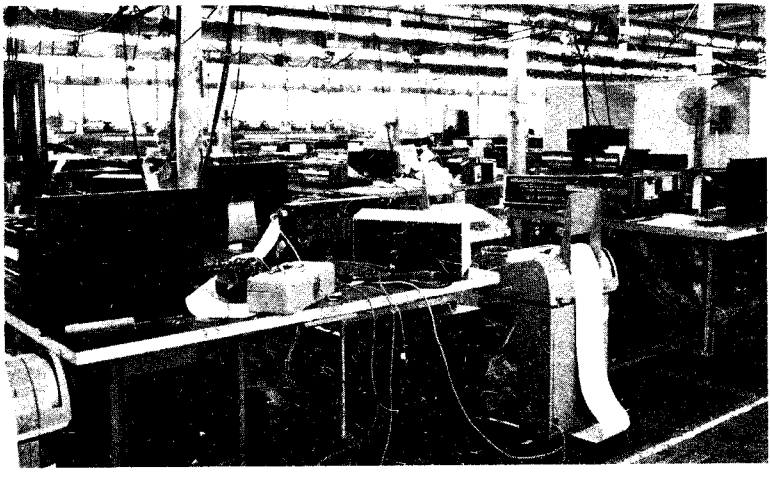


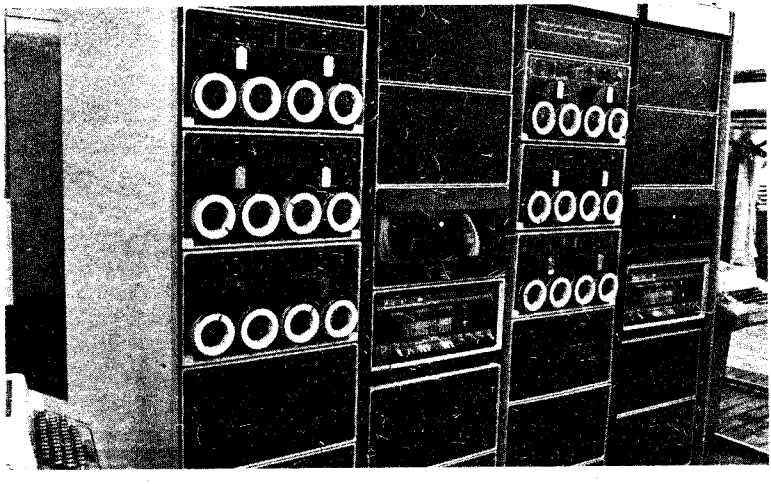
PDP-8/E System Assembly—After testing all the various components of a PDP-8/E Computer, the components are carefully assembled. This photo shows all of the components for a basic 4K Computer arranged to illustrate how modular the 8/E is and how spare parts can easily be the key to zero downtime.



Final Assembly Area

Here, 40 PDP-8/E Computers are shown in various stages of assembly. After assembly is complete, each unit is moved to another area where power is applied and the assembled unit is tested.

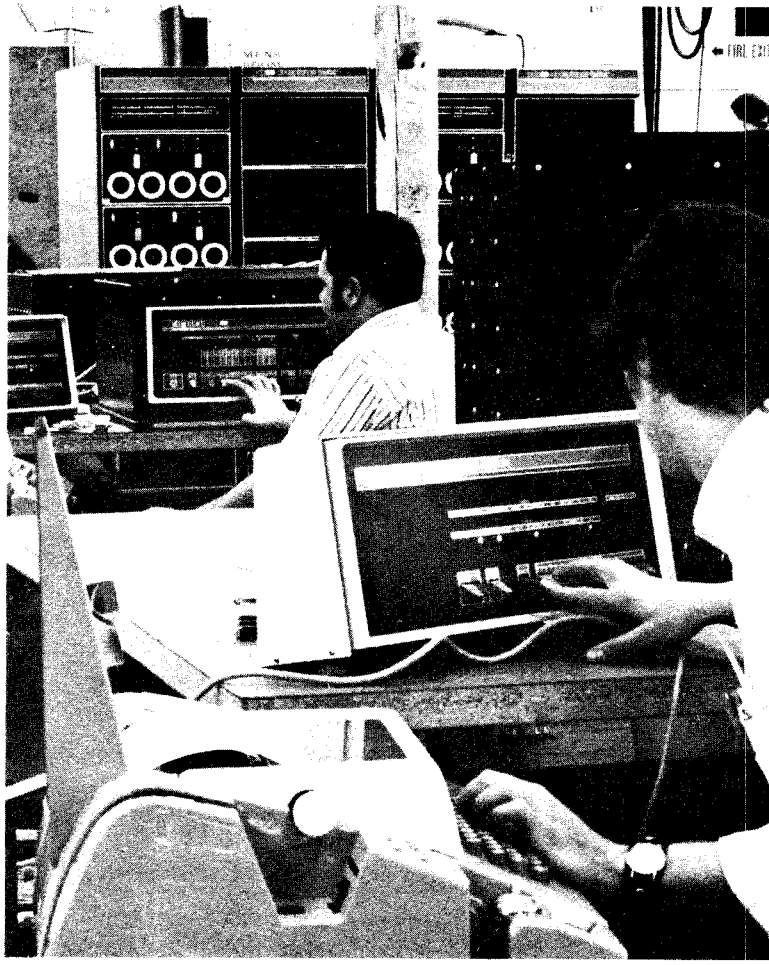




Acceptance Test Line

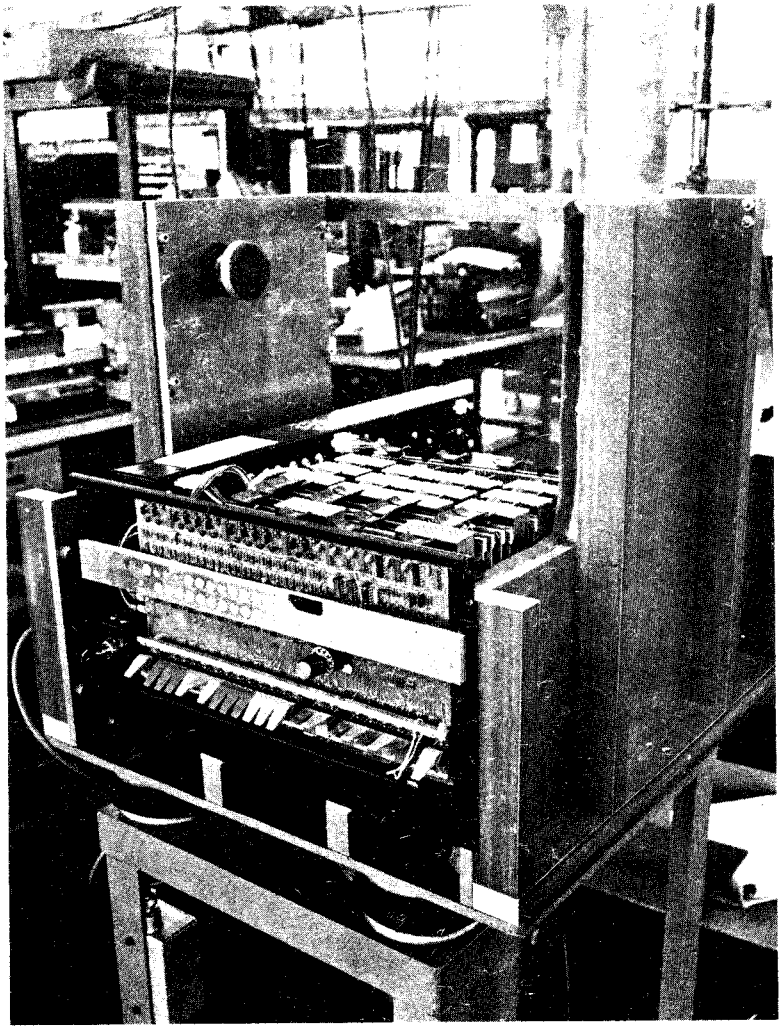
Assembled computer testing is done in DEC's acceptance test line. Up to 64 test stations can be controlled by one of two PDP-8/E Computer Systems; there are 6 DECtapes on each system, containing an assortment of test programs and exercises for each test station. Thus, 64 computers can be tested simultaneously by a master controller. The PDP-8/E master controller loads diagnostic programs directly into memory of the new PDP-8/E computers under test, thereby checking out the new computers thoroughly and efficiently. The DECtapes contain all of the programs required to check out the various PDP-8/E's, as well as the operating programs to control the entire test line.

(14) Computer Checkout



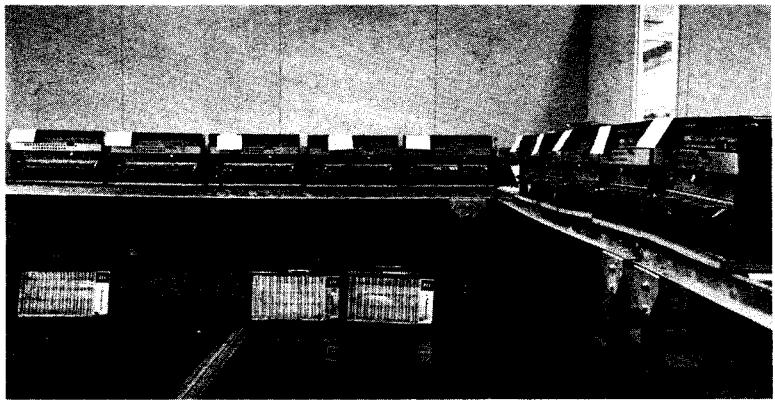
All assembled computers are tested at the 8/E Acceptance Test Station. By coding of the switches on the front of the computer, a technician can request certain diagnostic programs to be loaded into the PDP-8/E. Another switch enables Auto or Manual operation. The technician can either manually go through each test program while he is watching the results or place the switch in the Automatic Mode allowing the PDP-8/E Computer to continually cycle the various test programs through the unit without an operator. On the far left of the test panel is a switch labeled HEAT BOX. This switch activates the heater elements of another unit (not shown) and gives the computer a final heat test at this station.

(15) Vibration Test Station

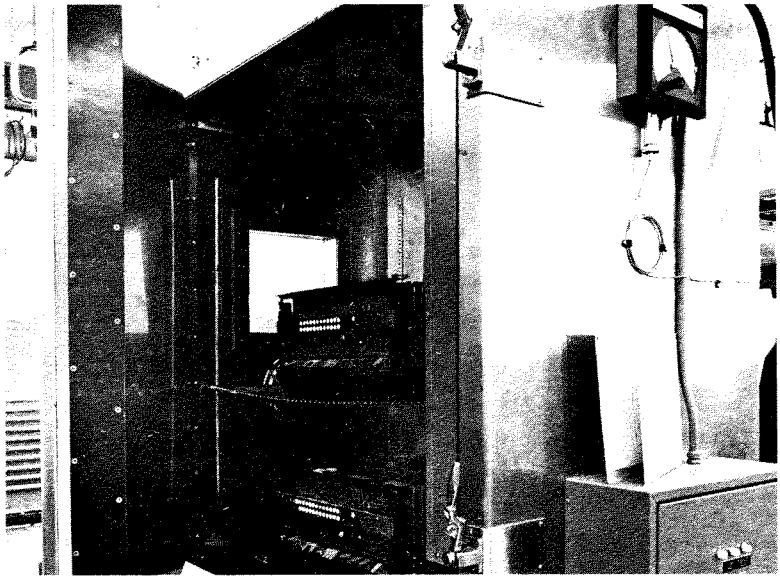


In this production phase of the computer testing, the 8/E is placed on a vibration table and vibrated for several minutes at 70 cycles per second. This test checks for any loose components, cold solder joints, and other malfunctions that can appear under severe vibration conditions. Following this test, the computer is rechecked with the various diagnostic programs. While the unit is undergoing the vibration tests, the memory checkerboard diagnostic is run.

(16) Sample 100-Hour Heat Tests



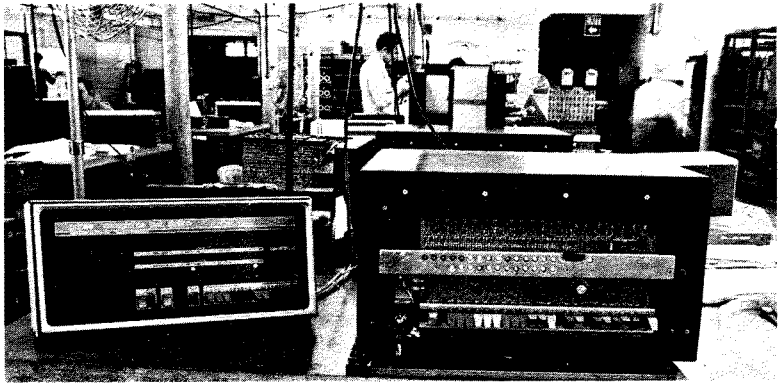
DEC takes a random sample of working PDP-8/Es and runs them for a period of 100 hours at 131° F. This workout allows us to check for "early failing components or sub-assemblies." The information gained helps us to improve the long-term reliability of all the units. In another test, all 8/Es are placed into a cold chamber at 32° F or 0° C. This forces a computer through another thermal shocking process with a very rapid change in its temperature. Following this cycle, the machine is returned to the heat room at 131 degrees F. This two-stage cycle not only verifies operation at the specified limits, but also subjects the machine to much more stress than the environmental change in the field.



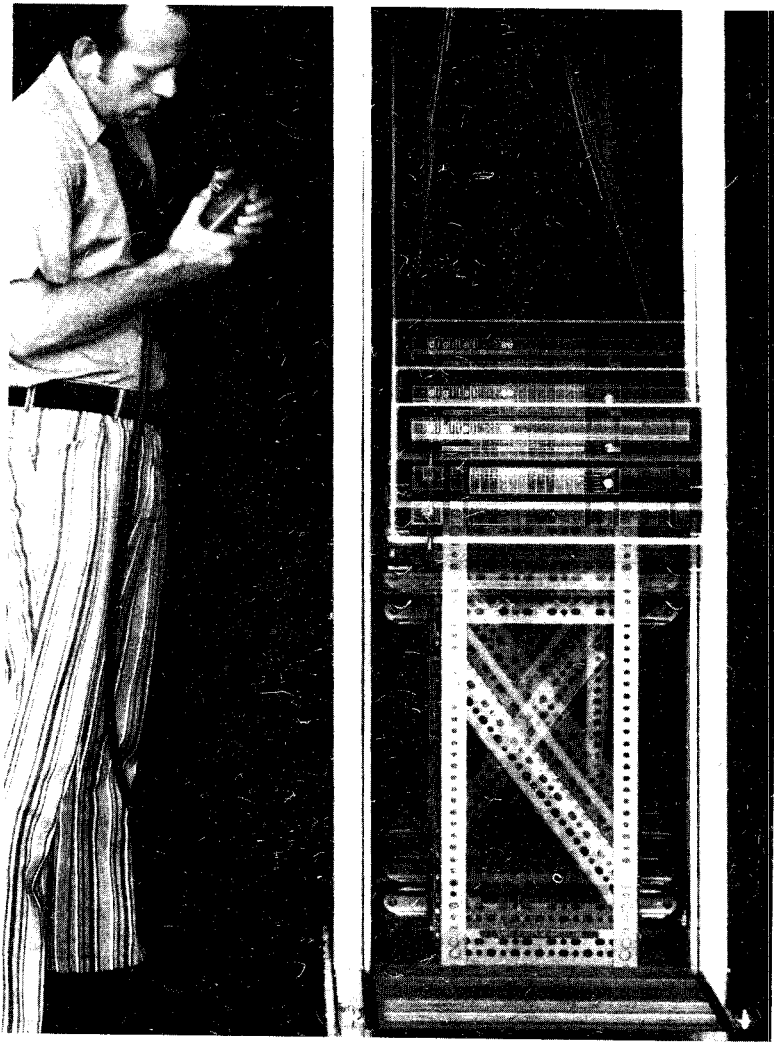
Cold Chamber

(17) Thermal Shocking

As a part of the testing and acceptance process, we place each computer in a cold chamber and a memory checkerboard program is run. The chamber temperature is reduced to the minimum specified temperature of the computer; then, the computer is placed in a heat chamber to operate at 131° F. The acceptance test station detects any faults while exercising the computer under test.

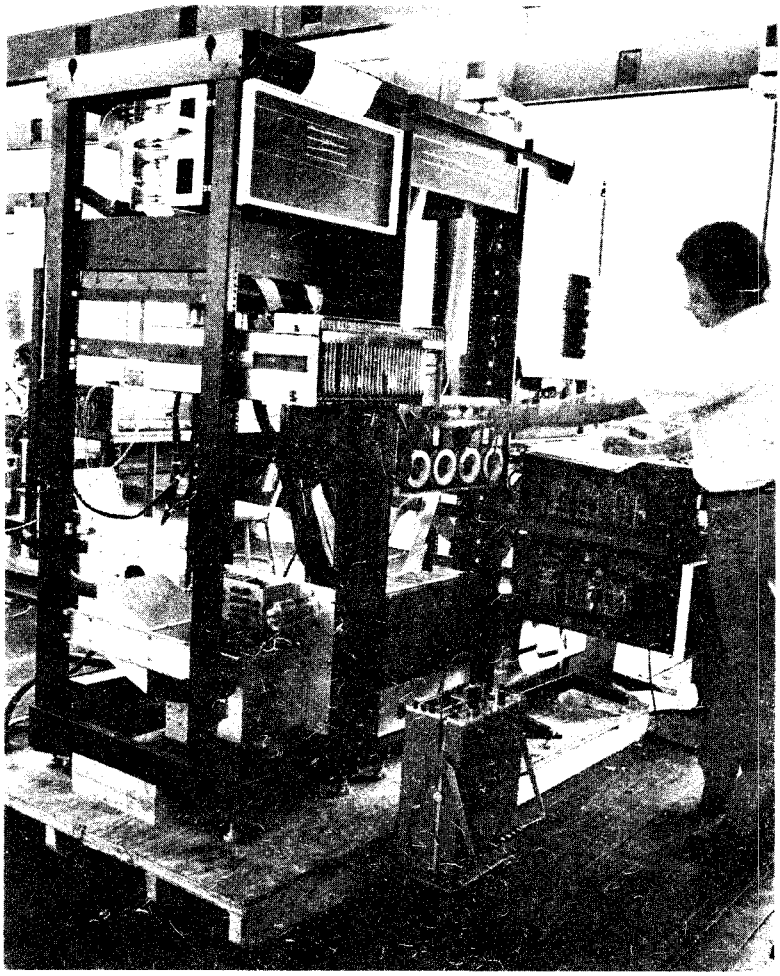


Heat Chamber



(18) The Drop Test
Some of the most frequent problems in initial installation of a computer are caused by the vibration and rough handling during shipment. To combat these problems, DEC has devised a test that is even rougher than your local transportation company. The 8/E is raised approximately 3 feet above the lower platform and then dropped *hard*. The test is calculated to place the various components in the 8/E under a 20G force. A second test is performed with the 8/E in a vertical position (panel up) with a 16G impact force.

(19) Quality Assurance and Field Service Acceptance
At the end of the acceptance test line, the Quality Assurance and Field Service Acceptance groups (independent of the production test groups) run their own tests to verify the quality and performance of the units being shipped.

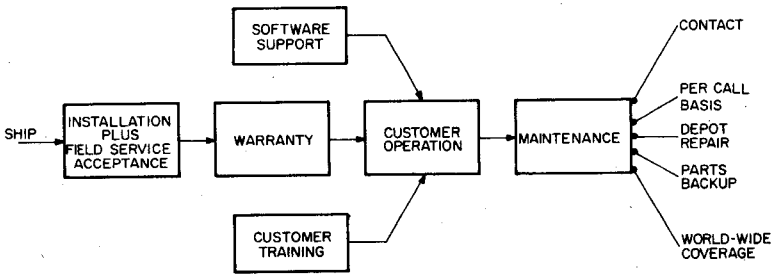


(20) PDP-8/E System Assembly and Test

After checkout of the basic computer and its internal options, the unit is moved to the system assembly area where it is installed in a cabinet containing peripheral equipment to form larger systems. In the system assembly and test area, all customer-ordered options are assembled and tested to make absolutely certain that the system is operating according to equipment and program specifications. This continuing testing process assures DEC's customers, all over the world, that each system delivered will go right to work for them and provide many years of reliable service thereafter.

CUSTOMER SERVICE

With the PDP-8/E computer fully checked out and shipped to a user facility, the scene shifts from the factory to the customer. Each PDP-8/E computer or system is installed by DEC's Field Service engineers. Each installation includes system performance checkout using a series of diagnostic programs and other programs to establish successful operation. Each system (depending upon the purchase agreement) is fully backed by a warranty which assures the customer of complete DEC support at no cost for a period of 90 days.



Customer Service

To further support the customer, DEC provides a software support service that assures a complete trouble-free operating software package.

For OEM* customers, DEC provides special documentation support on equipment produced by the OEM. DEC will provide a complete system package containing both theory of operation and maintenance.

How to use the PDP-8/E system and how to maintain it is another customer need that DEC satisfies by offering classroom and laboratory instruction designed to familiarize each customer with his system. Courses include programming, hardware familiarization and system familiarization that provides instruction on how to program a system, how to operate a system, how to maintain a system, and detailed knowledge of the system so that a customer may design and build interfaces to the system.

Each customer has the choice of maintaining his own system or employing DEC Field Service to support his system. His option does not stop there; he may elect to purchase a service contract or simply call his local DEC field service to obtain support on a per call basis. DEC support does not terminate; it continues throughout the life of the computer. The second PDP-1 computer system produced by DEC in 1959 has been supported by DEC Field Service for more than 12 years. This service will continue indefinitely.

* OEM — Original Equipment Manufacturer

CUSTOMER TRAINING PROGRAMS

Digital Equipment Corporation offers an extensive training program to every organization that purchases or presently owns a DEC computer. Our training objective is to familiarize the user with the hardware and software associated with his computer system, and with this in mind, we provide eleven courses for the PDP-8 Family Computers.

Software: (Programming)	Five courses ranging from a fundamental Introductory Programming Course to a sophisticated monitor system course. Designed to enable the user to: utilize the standard system software, write his own system programs, incorporate DEC programs as part of his system programs.
Hardware: (Maintenance) (Engineering)	Six courses ranging from hardware familiarization to system maintenance. Designed to enable the user to: isolate and evaluate problems if they occur, design interfaces for his system.

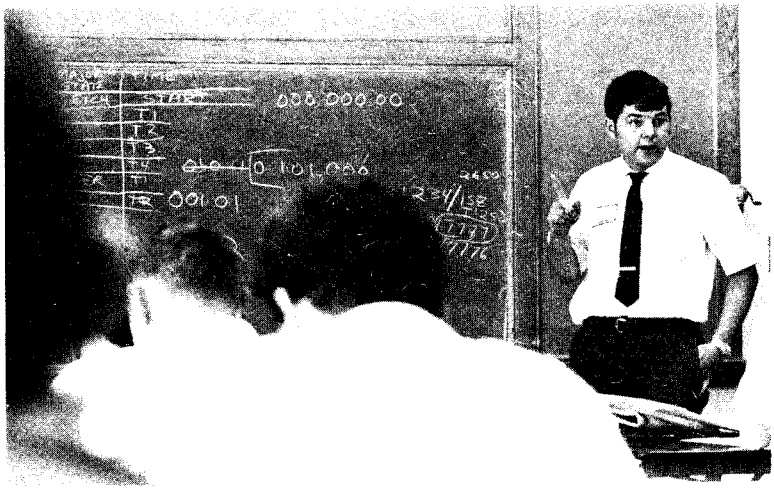
Digital offers training facilities in many countries in the world. We presently have training facilities in Maynard, Massachusetts; Palo Alto; California; Australia; England; France; Germany; and Scandinavia. Our training staff consists of full time professional instructors who continually re-evaluate our courses to ensure the content is current and that it meets the needs of our students. Special Arrangements can be made to conduct courses on-site.

The next few pages illustrate our training environment—from the formal classroom aspect to the lab sessions where the student reinforces his classroom learning with actual programming and debugging time on a computer system.

After completing their training, our students leave with a "can do" outlook. Come and find out for yourself.

For further information about our training program and the scheduling of our courses, check the appropriate block on the information request card in the back of the book.

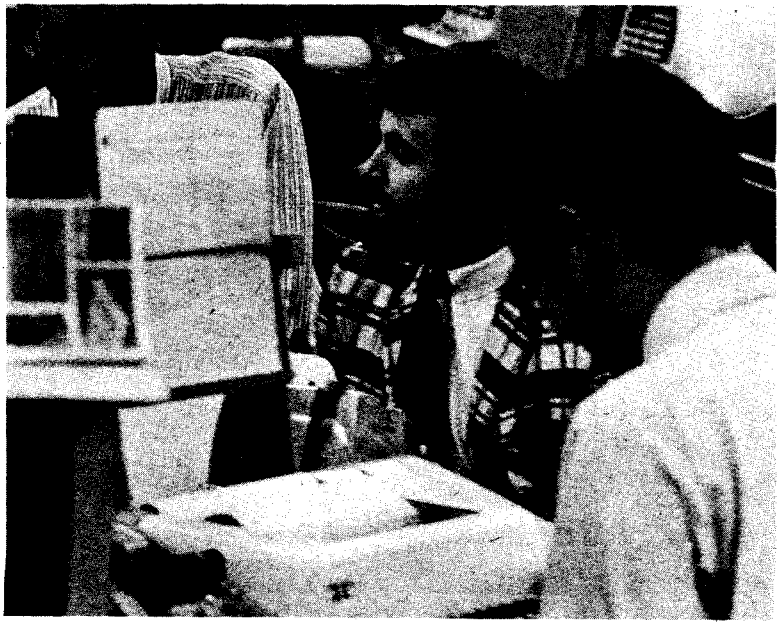
Each Digital customer is provided the opportunity to familiarize himself with all aspects of our computers and peripheral equipment. Professional class rooms employing the latest techniques are used to train customers to maintain and program the PDP-8/E and peripheral equipment. Well equipped laboratories with a complete array of equipment are employed to assure a high level of confidence of each graduating student. Courses are offered from the beginner level to the more advanced level of instruction.



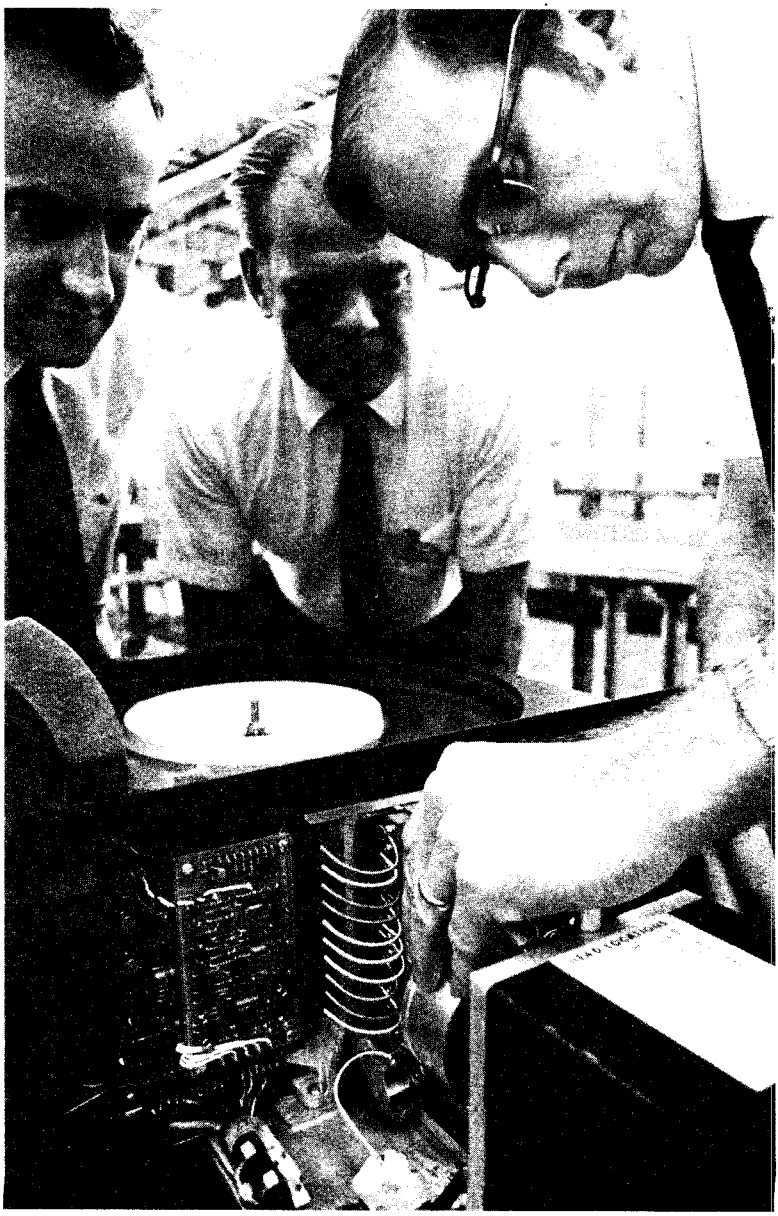
A hardware class goes through the logic with a timing breakdown.

Software students utilize lab periods with the computers to reenforce classroom learning.

One of the training laboratories—usually a very busy place.



Happiness is—an assembled, edited program that works.

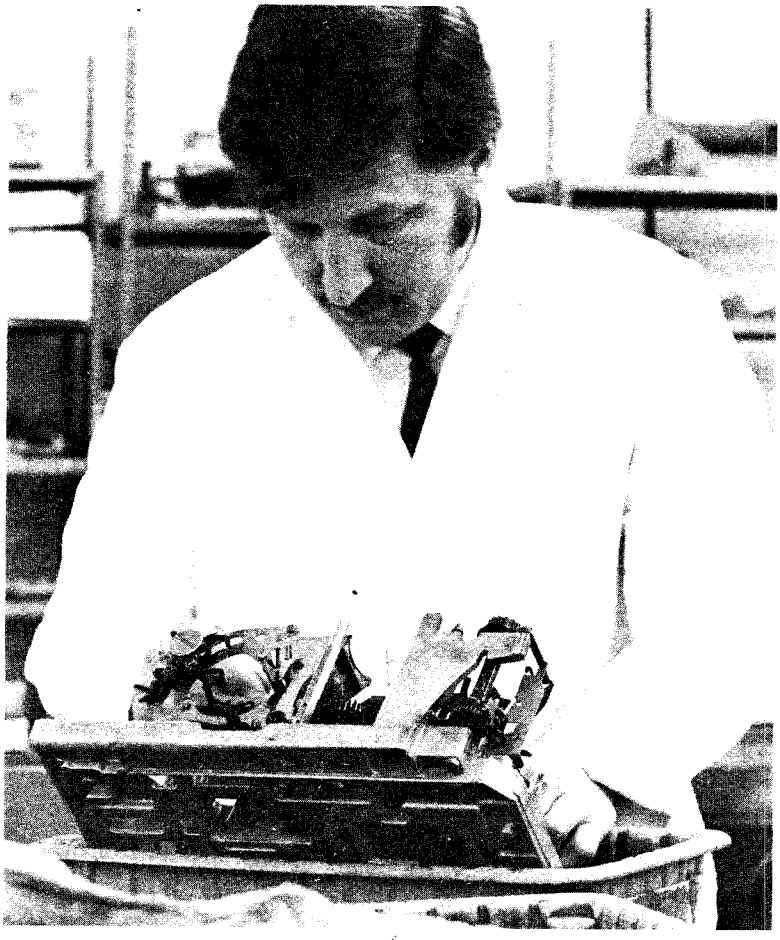


A peripheral class investigates the inner workings of one of our disk pack units.

REPAIR SERVICE

The key to maintaining your PDP-8/computer system is no further away than your telephone. Digital Equipment Corporation provides 113 service centers throughout the free world employing nearly 1000 trained engineers for repair and a complete range of technical assistance.

This field service engineer is not out to set the world's record on servicing a computer. However, like all field service engineers, he is fast, knowledgeable, professional, and courteous. It is men like him that give Digital Equipment Corporation "high marks" in field service.



For Depot Repair Service

Depot repair service saves the customer money and time. If you operate on a tight budget . . . . or if the DEC products you (or your customers) use are far from our service facilities—Digital's repair depots may be the most economical solution to your maintenance problems.

Depots provide cash-and-carry maintenance and repair service on Teletypes, computers, many standard options and peripherals. You save the cost of a service man's travel time and expense. DEC currently has depots in or near Boston, New York, Chicago, Houston, Los Angeles, San Francisco, Ottawa, Munich, and London. Other services provided at these depots include trading in your old equipment, converting your teletype or punch, etc.

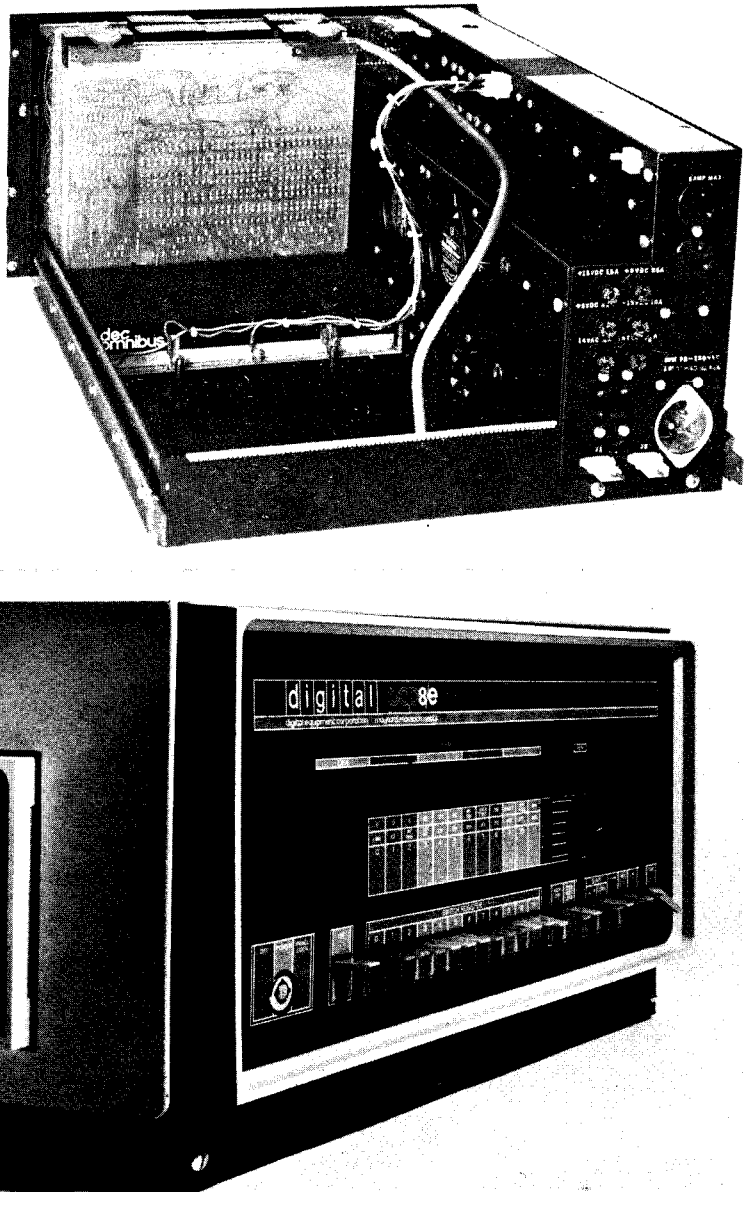
MAINTENANCE CONTRACTS

The best method of assuring that your operating system is performing in peak condition all of the time is with a field service contract. With a DEC Field Service Contract, a highly trained engineer or technician will come in at regular intervals and perform carefully planned preventive maintenance to keep your PDP-8/E in top condition. Should your computer go down, you're sure to get prompt, expert service to set it right again. Everything you need to keep up your computer is yours for a fixed monthly charge, whether you need little more than a quick dusting of the keys or a complete overhaul. All contract customers are preferred on a service priority basis.

Customer Service Contracts Guarantee Continuous Operation

part 1

BASIC SYSTEM



PDP-8/E Programmed Data Processor
(Table Model)