DIGITAL EQUIPMENT CORPORATION

pdp10

APPLICATION NOTE

Time-sharing system serves laboratory functions at Sanders

The Sanders Associates facility, Nashua, New Hampshire, that houses the Corporate Computer Science Division.

Versatility is the key to success of the in-house time-sharing system at Sanders Associates, Nashua, New Hampshire. In a typical day, the system aids engineers in designing circuits via teletype, simulates complex physical systems, operates on-line equipment tests, and performs return-on-investment analyses. And all of these tasks and more proceed simultaneously.

The time-sharing computer, a PDP-10 supplied by Digital Equipment Corporation, is at the disposal of Sanders scientists and engineers, 22 hours a day, seven days a week. Operated by the firm's Corporate Computer Sciences Division, the system serves some 300 users, some of them located as far away as Long Island, New York, and Reston, Virginia.

With 32 time-sharing terminals, 16 of which can be operated simultaneously, the system demonstrates some impressive usage figures. During a recent month, 147 users "logged onto" the system some 2746 times and clocked a total of 2057 terminal hours. On weekends alone, it's not unusual to have 90 "log ins."

Before the PDP-10 was installed in March, 1969, some 100 Sanders employees depended on the commercial services of several time-sharing service companies. With a present users list of 300, the in-house system has succeeded in maintaining the same overall scientific computing costs, since it replaced a large scale system used for simulation and scientific batch processing in addition to most of the outside time-sharing services. Costs for the in-house system average $15 per terminal hour —the bulk of this cost taken as equipment depreciation.

Circuit Synthesis and Analysis Via Time-Sharing

Since Sanders specializes in electronic systems, much of the work on the time-sharing system is aimed toward taking the drudgery out of design of the company's aerospace and commercial products. By automating the more routine aspects of design, Sanders engineers have more time to "create new directions in electronics"—a slight paraphrase of the company's motto.

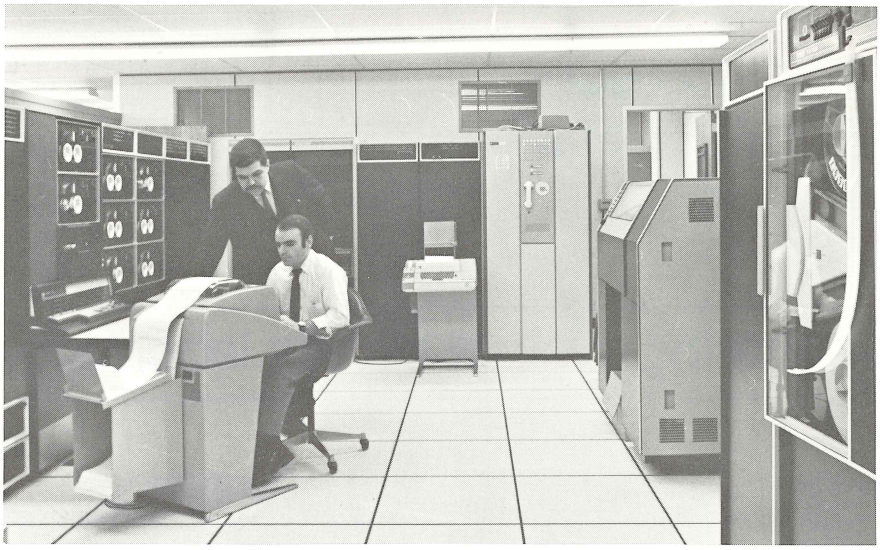
One of the programs that simplifies the engineer's design efforts is a filter circuit synthesis program written in BASIC. This program, which is run interactively, requires the characteristics of the desired circuit as input. For example, the engineer might specify the type of response, number of poles, upper and lower cut-off frequencies of the required circuit. The program then determines the design of the circuit using off-the-shelf components and providing the electronic values of each component. The user can also request the frequency response of the circuit and compare it with his original specification. If the resulting components are excessively expensive, the designer may adjust the original circuit specifications and try the program again.

Another program—this one designed specifically for time-sharing—is called IMPACT. Written in FORTRAN, this program allows the engineer to test a proposed analog circuit just as if he were using a breadboard model. The engineer specifies his circuit, using the part numbers of off-the-shelf components. (The characteristics of these components are contained in a special FORTRAN library.) Once the circuit is specified, the engineer can ask for the transient response or request a complete DC analysis with both peak and average power levels. He can substitute new components, run the tests again, or cause a particular component to fail and observe the results.

Eventually Sanders hopes to integrate these two programs and supply a third program which will compute the details necessary to building the circuits.

Analysis of Microwave Networks

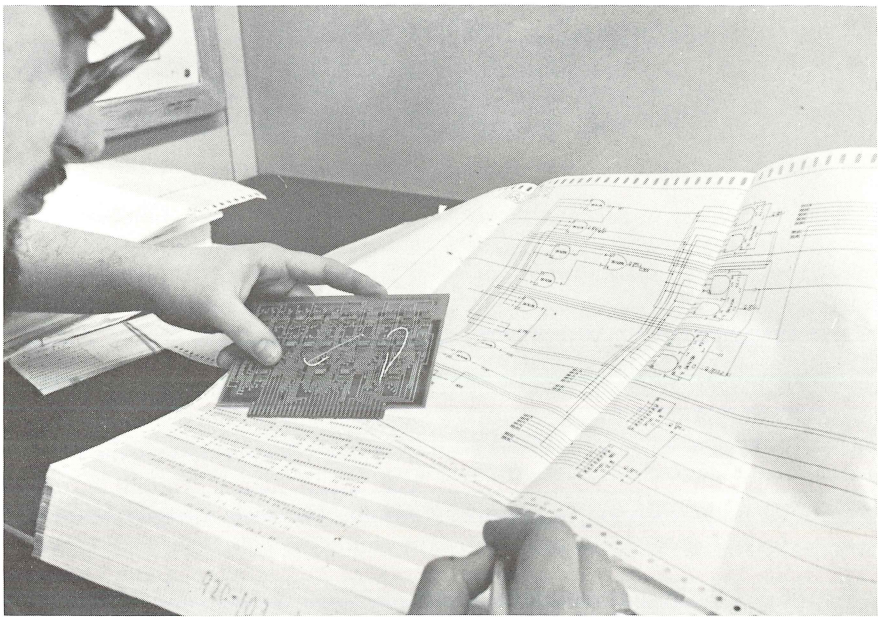
FILTAN is another design program which allows engineers to analyze circuit performance before the circuit is built. Specialized for microwave networks, the program allows the engineer to describe his design in terms of transmission lines, stubs, inductors, resistors, and capacitors. He can then request printouts of such characteristics as voltage standing wave ratio and transmission loss. For convenience, variables are expressed in microwave terminology, frequency in GHz, transmission loss in dB. Since this program is fully interactive, a microwave engineer can easily change his design, then operate the program again to check the analysis.



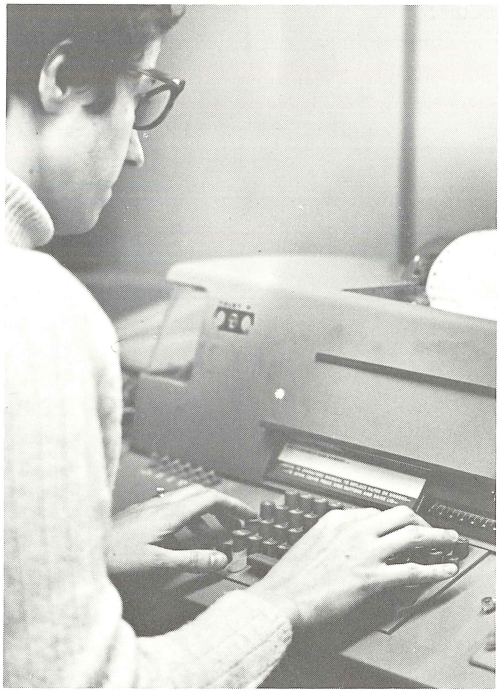
The PDP-10 computer system—hub of the service used by some 300 Sanders scientists and engineers.

Digital Circuit Design

In digital circuit design, the PDP-10 assists in the development and diagnosis of programs to be run on adjoining IBM System/360 machines. From his teletype, an engineer can write his program, specifying the Boolean equations and the off-the-shelf components. He can then debug the program from the terminal and store the results on PDP-10 disk. After the program is transferred to tape, it is fed to the 360 where the batch-operated program designs a hardware implementation of the Boolean equations and provides all the information necessary to build the circuit. For example, it supplies such information as wiring and external connection lists, and prepares a logic diagram for output on a plotter.



Digital circuit design—checking the final circuit against the logic diagram and wiring lists.



The PDP-10 tests this small computer, performing a laboratory task, while time-sharing is going on. (Right) Software for the small computer can be developed from one of the teletype terminals while the small machine is being tested.

The PDP-10 for Laboratory Work

In purchasing the PDP-10, Sanders had more in mind than interactive time-sharing; they needed a multi-function machine which could handle scientific batch processing as well as the simulation and on-line testing functions required by many projects. Some of these latter functions were performed by a large scale computer at a cost of $15,000 per month. In addition, small computing systems were often leased or purchased to solve specialized laboratory problems.

The PDP-10, which has replaced the earlier system and obviated the smaller systems, provides these projects with the facilities of a large system, allowing them to share peripherals and use the same software and operations staff. Through interactive time-sharing, project software specialists can develop programs simultaneously. In addition, the PDP-10 performs the testing functions which often require only a few hours a week—at no increase in system overhead.

In a current project, Sanders is designing a military command and control system in which a small computer receives and processes input from a series of external sources and feeds data to a large Sanders display unit. Were the PDP-10 not available, project personnel would have to spread their work over three working shifts. Also, once hardware and software were developed, another computer would be necessary for simulation and testing.

With the PDP-10, much of the work for this project will proceed in parallel. Several software people, for example, will use terminal time-sharing to develop the software for the small computer, while hardware personnel install their equipment on the small machine.

Once the programs are developed, the PDP-10 will test the performance of the hardware/software combination. By simulating the inputs to be received by the small computer, the PDP-10 will put the machine through its paces, checking its capabilities under a wide range of possible conditions. Results of the tests will be recorded on PDP-10 peripherals.

Indirect Job Entry

The PDP-10 can also be used to submit jobs for operation on either of two IBM 360/50 machines. Rather than mail stacks of cards to the computer center, remote users can submit IBM 360 programs, via their teletypes, directly to the PDP-10. With the program stored on disc, the user then has the option of modifying his program or performing a test compilation. Programs ready to be run are transferred from disc to magnetic tape and submitted to the appropriate machine.

When a tape is made, the copying program also generates a line printer listing containing essential job scheduling information. The tapes, which are processed four times each working day, even include commercial data. For example, labor and clock card data is submitted by teletype from the Sanders facility in Reston, Virginia.

Other Sanders Projects

The foregoing are only a few of Sanders current time-sharing projects. Other non-proprietary jobs include developing a character generation technique for a small display and performing signal processing with the PDP-10. And the system even serves an important educational function. In its non-prime hours, the PDP-10 is helping some 44 Sanders employees toward Masters degrees in Computer Science. The course on simulation and system optimization, based on GASP— a discreet simulation language, is being given at Worcester Polytechnic Institute, Worcester, Massachusetts.

Backing the system is also a strong systems programming effort. For example, Sanders has developed a specialized accounting package to assure the costs are charged correctly and to the proper projects. The package takes into account both the project and the programmer, since a programmer can work on several pro-

jects in a day. In another project, Sanders personnel devised a DECtape protection scheme which keeps the wrong DECtape from being mounted and its information accidentally destroyed. With over 500 DECtapes in current use, the firm found it essential to protect DECtapes in the same manner as disk files.

System Success

The busy time-sharing service bureau is a tool that more and more Sanders employees are utilizing. By using specialized programs they can save weeks of breadboard testing and development. In other areas, they develop their own programs to save hours of calculations and plotting. The system is also simplifying laboratory work and saving rental fees for small specialized machines. Scientific computing costs are better consolidated and easier to account for. But one of the best measures of success is savings. Even though user lists have tripled, computing costs are equivalent to those incurred before the PDP-10 was installed—an excellent record even for a leading innovator in the electronics industry.

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