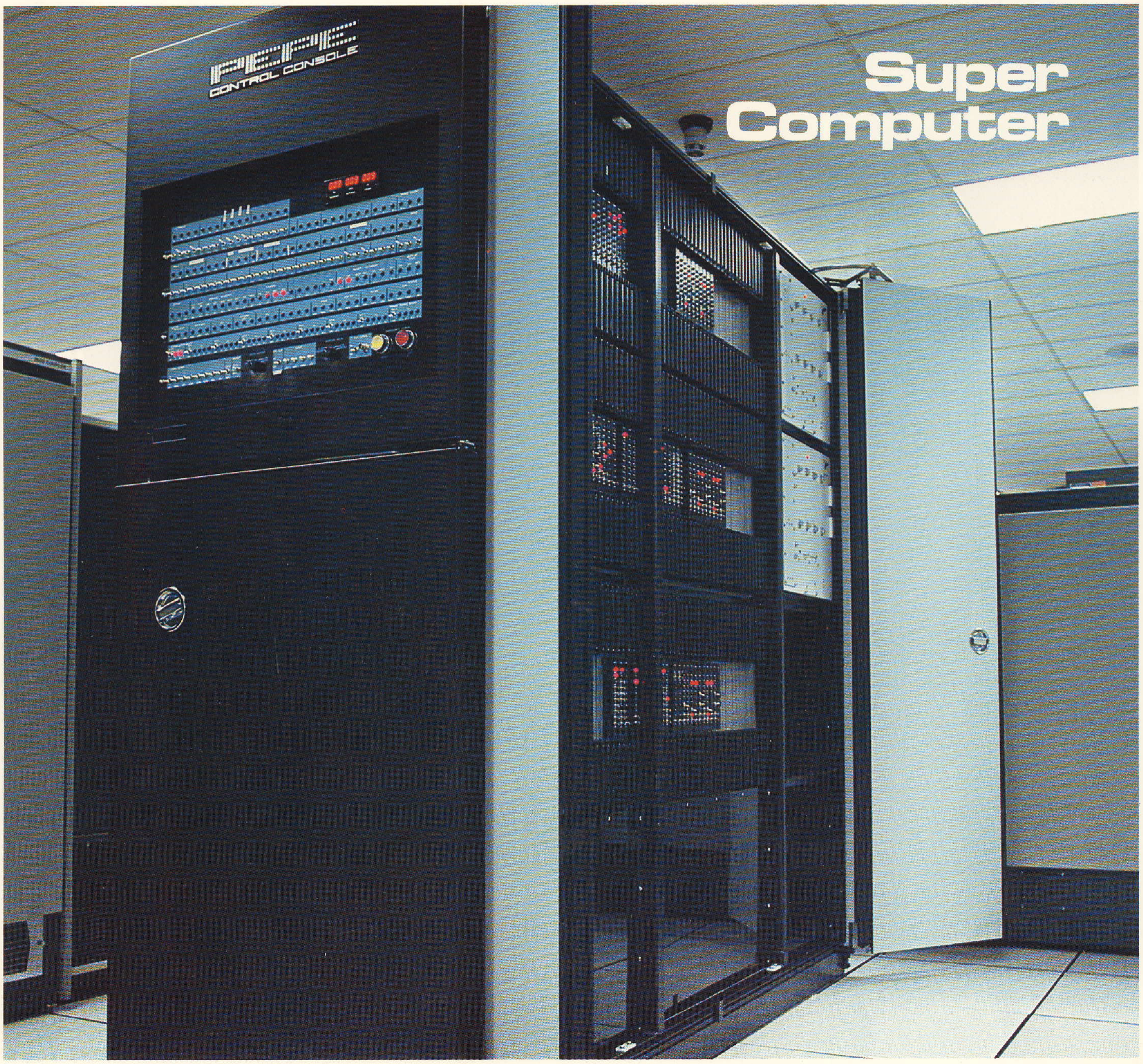
System Development Corporation



PEPE, The Super Computer

More than 50 percent of the work force in the United States today is involved in some way in developing or processing data.

You could say we've entered the era of information.

A lot of it comes thick and fast and calls for split-second decision and/or phenomenal processing power—in fields such as ballistic missile defense, air traffic control, weather forecasting, image data processing, signal processing, economic forecasting and computer modeling.

Today's super jobs call for a super computer. That's PEPE. Parallel Element Processing Ensemble. The fastest and most powerful computer in the world.

PEPE was originally conceived as a key element in our country's ballistic missile defense research program under the auspices of the Ballistic Missile Defense Advanced Technology Center. It was designed by System Development Corporation, on contract, and built by the Burroughs Corporation, on subcontract, for the United States Army.

In a nuclear battle, it would be PEPE's job to initiate a file on each radar-detected object, associate each radar return with its proper file, employ the information in each return to update the file, perform complex mathematical functions on the files and generate requests for additional radar information. Those requests which are granted are transmitted to the radar in the form of orders. The radar transmits the ordered pulses, new returns are thereby obtained, and the radar-computer loop is closed.

In short, PEPE was developed to process all available information on potential ballistic missiles entering our atmosphere. Do they carry warheads? What are the trajectories? How much damage could they do? And what would we need to do to thwart them?

It is a processing problem of keeping a large, complex data base updated in real time.

Now PEPE, the computer system designed to process this voluminous and exacting data, is ready to be put to a wide variety of peacetime research applications in such areas as fluid dynamics, large scale simulation and atomic energy.

Robert Sidnam
PEPE System Design Manager

PEPE BMD Data Processing Design Requirements

First, PEPE had to be able to correlate verified radar search returns with data already on file in the computer memory, then make predictions based on this information. Sequential processing proved too slow to perform this function efficiently. Therefore PEPE was given associative data input characteristics, or the ability to compare and process many pieces of information simultaneously.

Second, lengthy scientific computations on many sets of data were called for from PEPE, which dictated parallel processing characteristics.

Third, PEPE had to be able to perform multidimensional file searches, which called for associative data retrieval and output abilities.

Most importantly, PEPE had to be extremely reliable, with reliability built into the system. So PEPE was designed to keep individual elements independent of each other. Should one element fail, data are simply transferred to another.

And finally, PEPE had to be capable of easy expansion to meet increased requirements. This, too, pointed to a parallel, associative design, where elements could be added with little or no impact on existing programs.

PEPE Architecture and Application

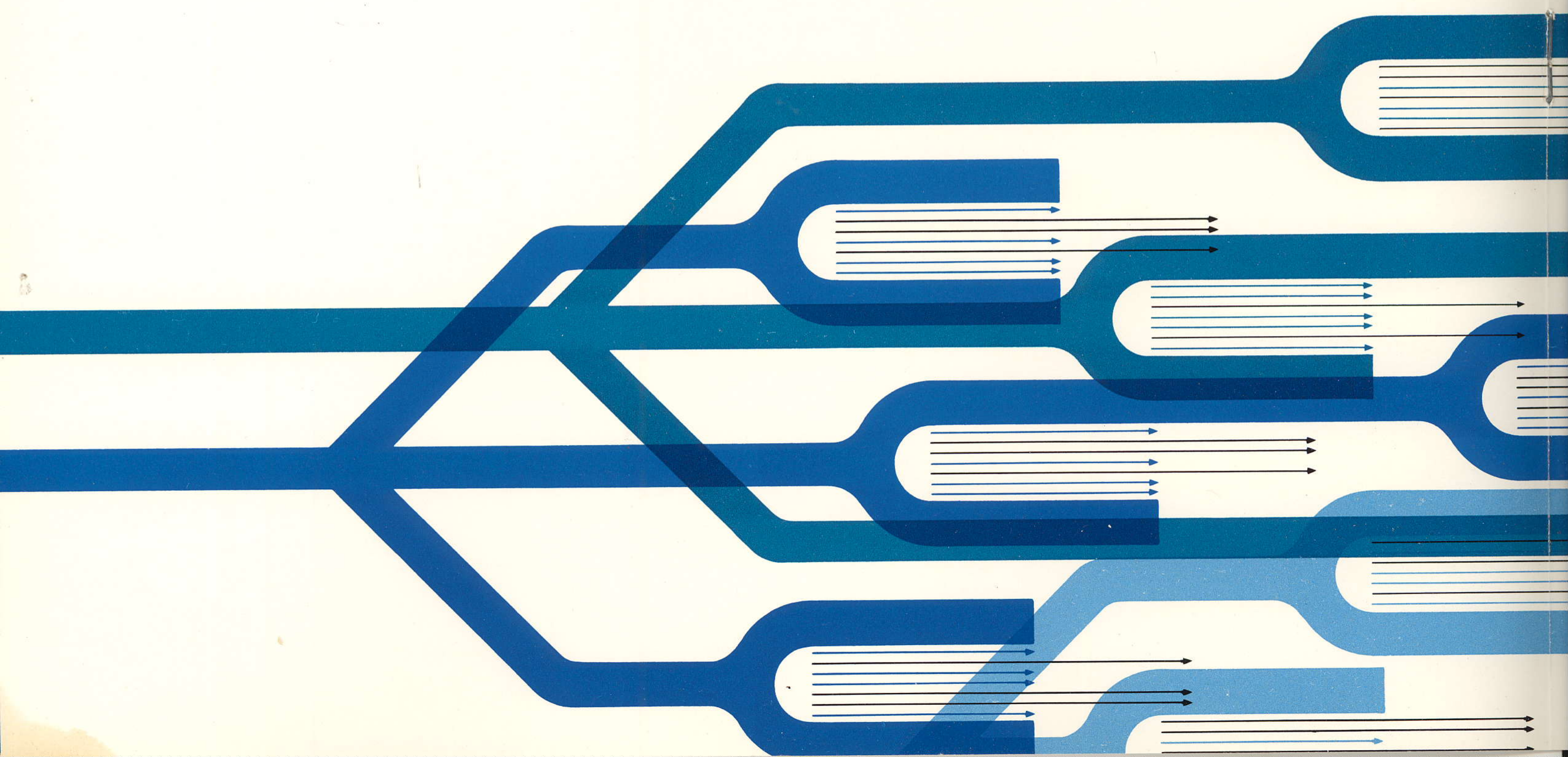
The computer that meets the foregoing specifications—PEPE—contains 288 elements that can provide more than 288 million floating point operations per second, simultaneously with input correlation computation and associative output.

The PEPE computer is composed of a control console and up to eight 36 element bays connected to a host computer. Currently the CDC 7600 computer serves as host.

The control console is itself comprised of three independent control units, for arithmetic, input correlation and associative output control.

Each control unit is equipped with its own modular host interface unit. By replacing these interface units, other interface connections with different host machines may be made.

The host computer provides overall executive control, loads program and initial data into PEPE memories, schedules and dispatches appropriate tasks to PEPE, and executes those sequential tasks it performs more efficiently,



as well as such utility functions as compiling PEPE programs.

The arithmetic control unit controls the arithmetic units in PEPE elements so they can execute the required parallel algorithms in an efficient manner. In addition, it executes sequential instructions retrieved from its program memory in a manner similar to that of a conventional processor.

The arithmetic units, provided they are active, all execute the same instructions simultaneously on data obtained from their own local data memories. The parallel instruction set is quite rich, containing the conventional arithmetic operations—plus square root—in both integer and floating point, load, store and logical operations. Each element can execute more than 1 million floating point instructions per second.

The correlation control unit broadcasts a sequential stream of input data from the host computer or some other source to all elements and enters words from the input stream into properly activated elements. Its instruction set is rich in associative match and compare operations, so that incoming data can be rapidly and efficiently correlated with data already in element memory and thus be placed in the proper elements. The average instruction execution rate of the correlation unit is about 5 million integer instructions per second.

The associative output control unit extracts data sequentially from properly activated element memories. Data output is sequential in any associative memory. In PEPE it is by 32 bit word. The associative output units, like the correlation units, execute instructions at the rate of 5 million integer instructions per second and they share element memory.

The associative output unit processor in each element is specifically designed to provide associative multidimensional file search for output, ordering, resource allocation and decision-making.

These features mean that PEPE can provide, depending on the problem, up to 288 million floating point instructions per second plus 2,880 million integer instructions per second. That's more power than any other computer in the world.

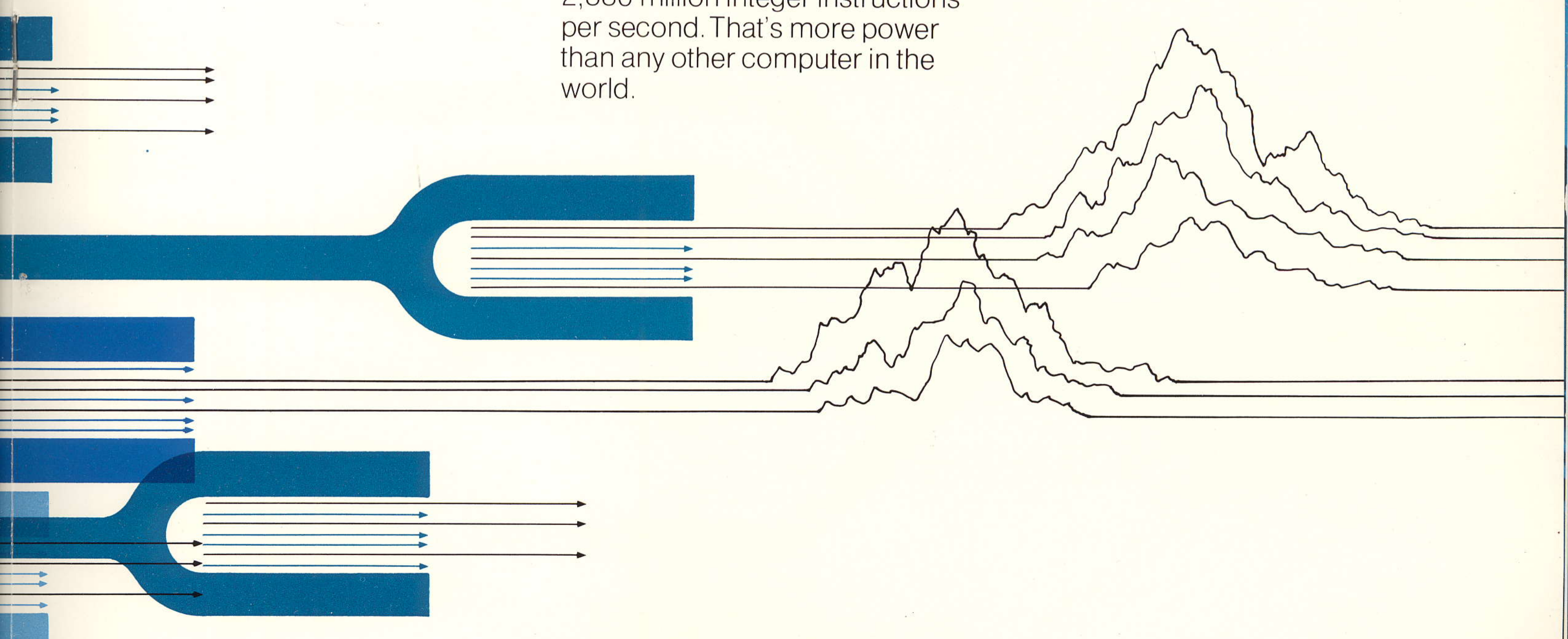
It is power to meet not only the sophisticated requirements for Ballistic Missile Defense, but an evergrowing number of other applications.

In the field of fluid dynamics, for example, the PEPE system can be tailored to efficiently solve problems in such areas as upper atmospheric research, meteorology, oceanology, and air pollution monitoring and control.

Through computer modeling, the PEPE system can complement the wind tunnel in aircraft and re-entry vehicle design.

The same large-scale simulation capabilities called for in staging world-wide war-game simulations and satellite command, control and communications simulations can be adapted in the civil sector to simulations involving air traffic control, urban traffic control, urban planning and land management.

And the energy crisis has brought into sharp focus the need for a computer on the level of the PEPE system in the advancement of nuclear energy as a primary power source.



Software

PEPE's support software system comprises a real-time executive system, a PEPE operating system, an instruction-level hardware simulator, a procedure-oriented language and translation system, and a general utilities package. All operate under control of the CDC 7600 SCOPE 2 operating system.

The *real-time executive* schedules tasks for execution on the host and other PEPE processors and dispatches tasks in accordance with priorities and satisfied precedence relationships. The real-time executive resides and operates in both the CDC 7600 host and the PEPE arithmetic control unit.

The *PEPE Operating System,* which includes the real-time executive and supplies support services for it, has components which reside and operate in the host and all three control units. It includes primarily interrupt and input/output handlers, as well as data buffers for host/control console input/output operations and storage space for the process control tables which support the real-time executive.

The *instruction-level hardware simulator* is used to precheck applications code, run performance tests on ensembles containing up to 1,000 elements, and check proposed hardware modifications before they are implemented.

PEPE is programmed in *PFOR,* a procedure-oriented, higher order superset of FORTRAN, that includes parallel FORTRAN, sequential FORTRAN, and PEPE assembly language sub-sets.

PFOR is an extremely easy language to use and PEPE is easy to program. FORTRAN programmers can learn to program PEPE within a week. PEPE programs, generally, are characterized by a structural simplicity which makes them easy to read, understand, debug, and modify. A great advantage is the relative absence of complicated program loops and housekeeping operations on data locations.

The *PEPE utilities package* comprises loaders, editors, debug aids and data recording programs, what you would expect for use with a totally supported computer system. The implementation of these programs with PEPE is unique, however, because of its parallel/associative architecture.

The PEPE prototype is here, from System Development Corporation. It can be tailored to a wide variety of parallel associative processing situations. Since the instruction set is micro programmed in random access memory, it can be modified easily to meet special requirements. PEPE can easily be adapted for use with almost any host computer. Moreover, the number of elements can be selected in accordance with requirements.

It would be our pleasure at System Development Corporation to introduce you to the operation of the PEPE super computer and to formulate with you the ways in which the PEPE system can be adapted to meet your specific needs.

Just write or phone Vice President, Plans and Programs, Government Systems Division, 2500 Colorado Avenue, Santa Monica, California, 90406, (213) 829-7511, and set a date for your introduction to the PEPE super computer.

Benny Sisk
Systems Specialist

Howard Welch
Computer Systems Specialist

Jerry Schweitzer
Senior Electronics Technician
Burroughs Corporation

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MCDUINIT SUCCESSFULLY TERMINATED
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MPMINIT SUCCESSFULLY TERMINATED
THE ACU IOU3 HAS BEEN SUCCESSFULLY TESTED
IOU3INIT SUCCESSFULLY TERMINATED
THE CCU DATA MEMORY HAS BEEN SUCCESSFULLY TESTED
MEMINIT SUCCESSFULLY TERMINATED
PEPE IS NOW MASTER CLEARED
SUCCESSFUL COMPLETION OF THE PEPE SYSTEM INITIALIZATION
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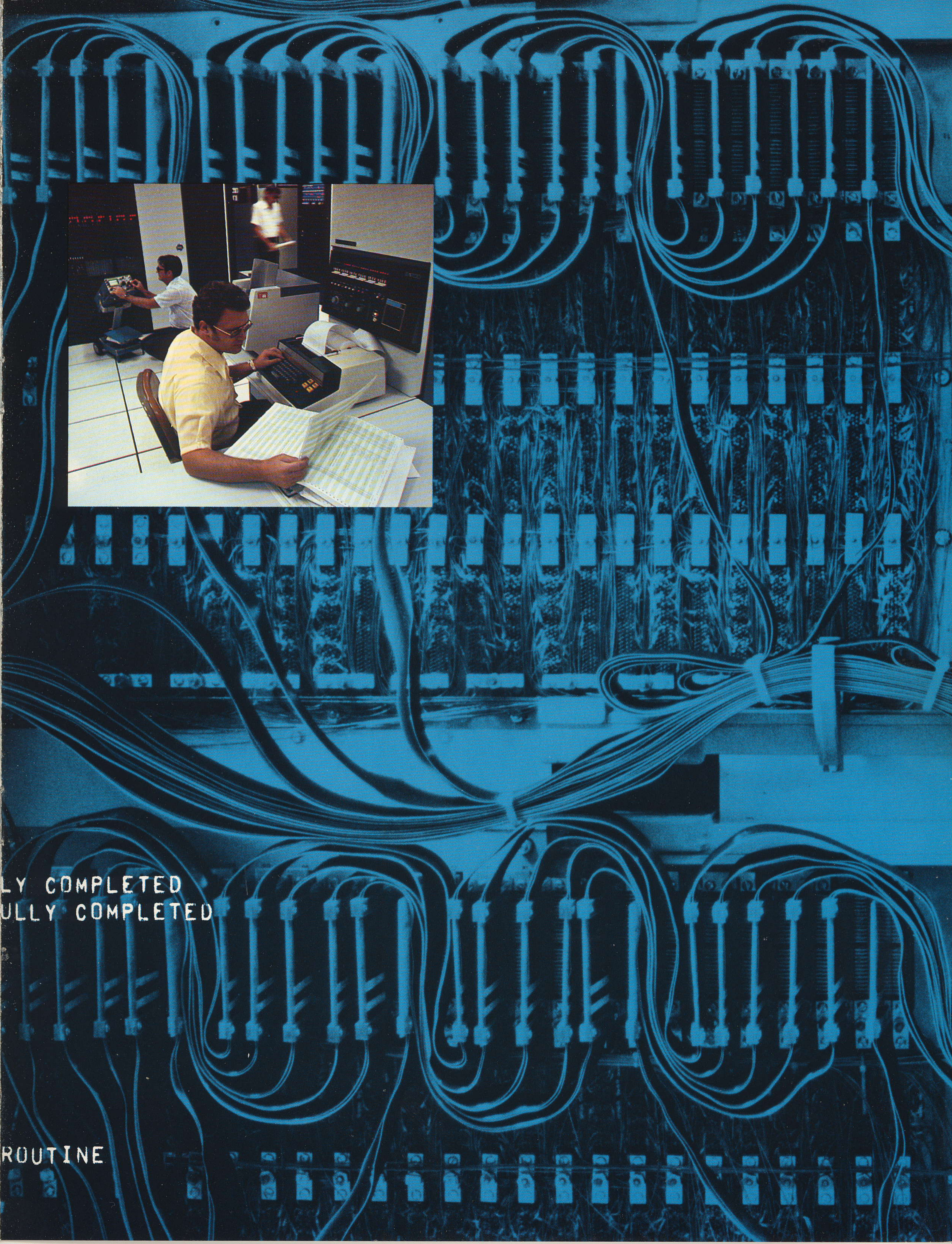
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ROUTINE

System Development Corporation, since its inception in 1956, has pioneered in the creation of effective information management and data base handling systems. Today SDC ranks as the most experienced information systems company in the world.

Turnkey systems that automate newspaper typesetting operations and facilitate passenger movement in public transportation; computerized transaction systems that eliminate paperwork and speed service in banking and insurance; energy systems to develop our nation's fuel resources; and management systems that speed vital information to business and military leaders for split-second decision-making—SDC has had a part in developing these systems and many more.

With nearly 4,000 employees and annual sales exceeding $110 million, SDC has successfully executed contracts totaling more than $1 billion.

An international corporation, SDC has subsidiaries and joint venture companies in Japan, Spain and Canada, as well as major facilities across the United States, several domestic subsidiaries, and offices throughout the U.S., Canada, Western Europe and the Pacific.

For highest quality systems technology, rely on SDC—the total systems company.

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