11 NOVEMBER 1983 · VOL. 222 · NO. 4624 $2.50

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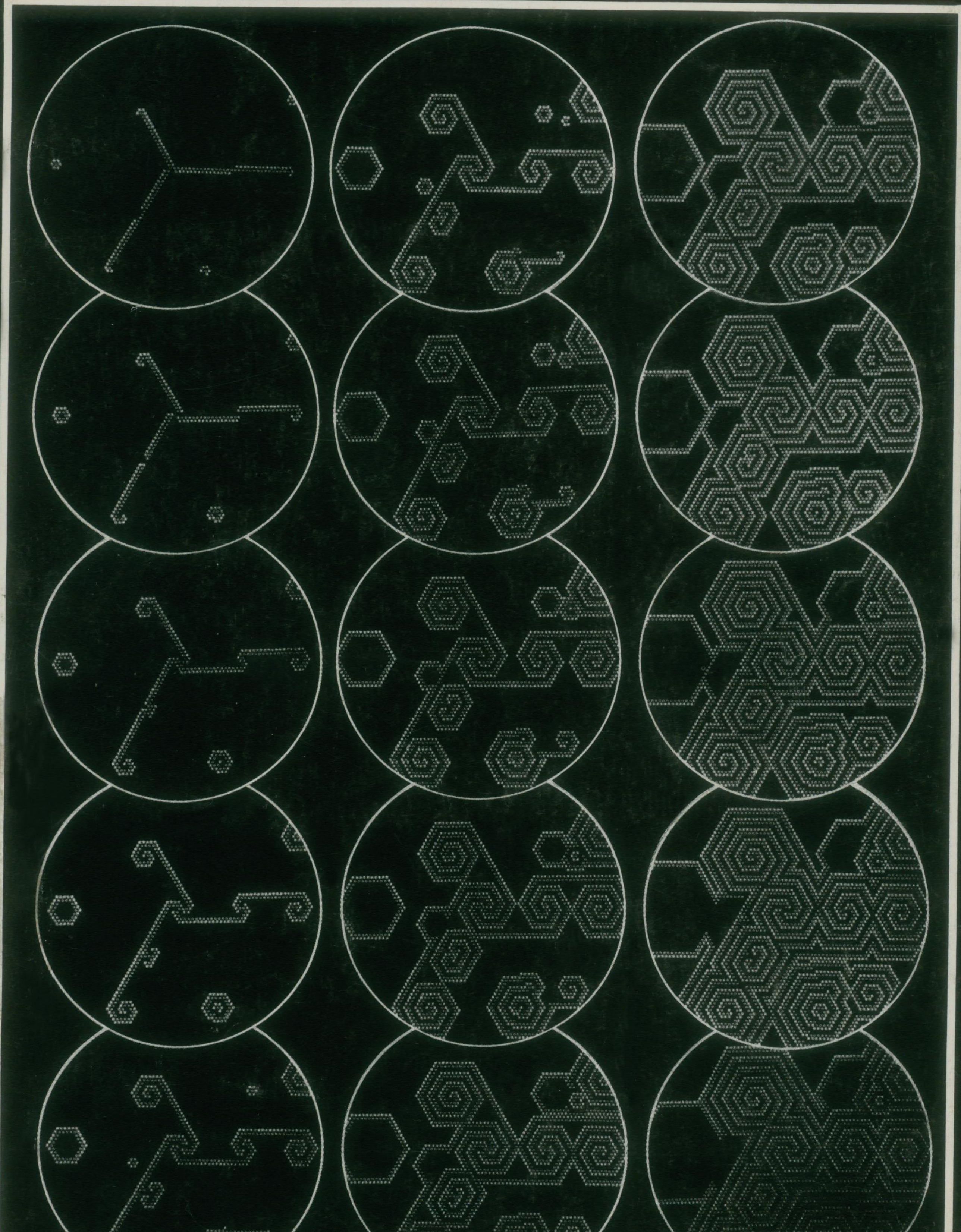

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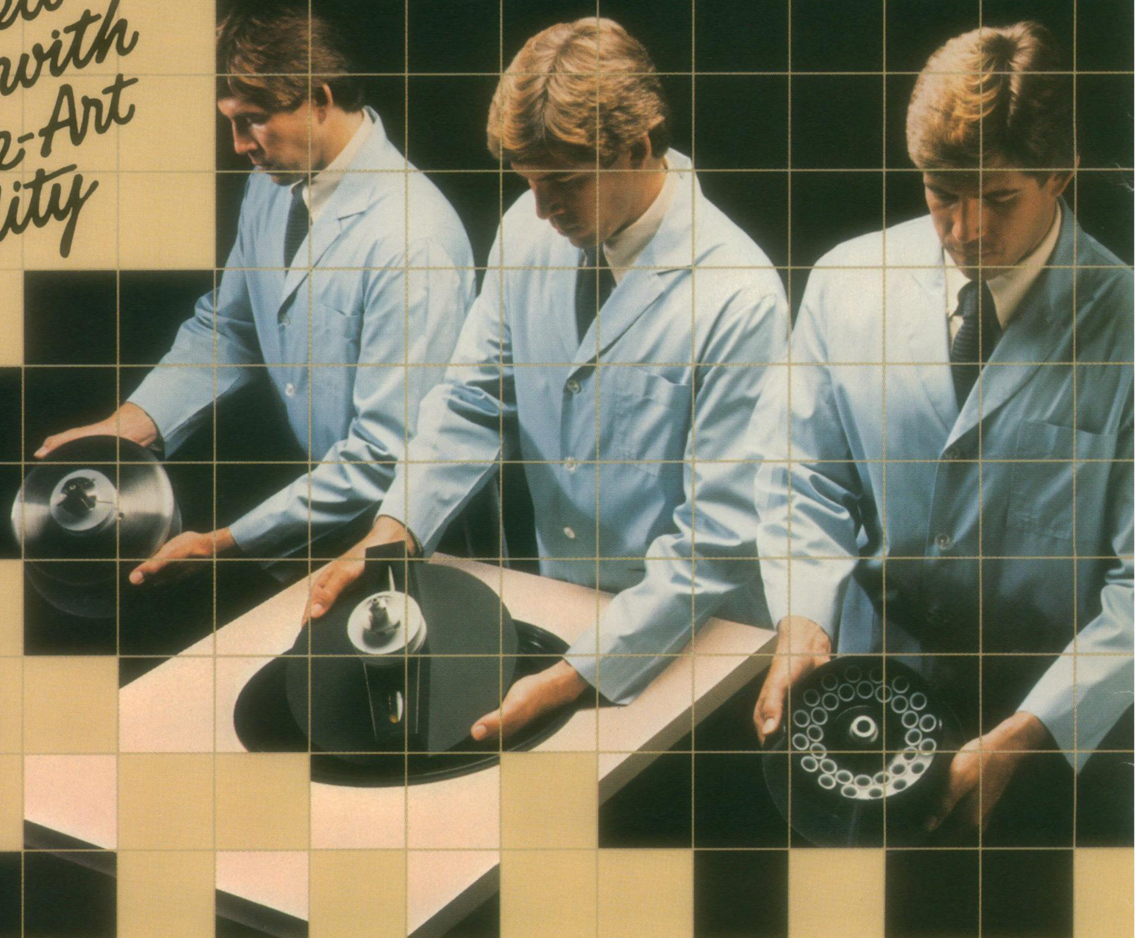
Now, a High-Speed Centrifuge with State-of-the-Art Flexibility



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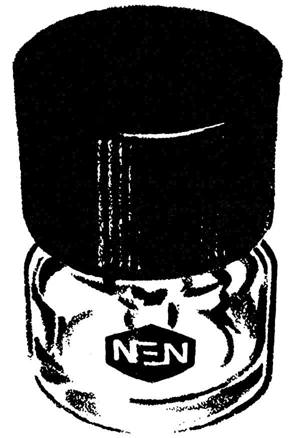

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COVER

Two-dimensional Belousov-Zhabotinsky reaction in the laboratory shows the remarkable self-organizing properties manifest in a variety of geometrical forms. Computer simulations running from a variety of initial conditions grow deterministically, and spontaneously model the laboratory experiments. See page 615. [Barry F. Madore, Department of Astronomy, University of Toronto, Toronto, Canada M5S 1A1]

Relational Data Base

IBM

To: Dick
From: Bill
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list? Thanks.

- Vacuum tube digital multiplier
- IBM 603/604 calculators
- Selective Sequence Electronic Calculator (SSEC)
- Tape drive vacuum column
- Naval Ordnance Research Calculator (NORC)
- Input/output channel
- IBM 608 transistor calculator
- FORTRAN
- RAMAC and disks
- First automated transistor production
- Chain and train printers
- Input/Output Control System (IOCS)
- STRETCH computer
- "Selectric" typewriter
- SABRE airline reservation system
- Removable disk pack
- Virtual machine concept
- Hypertape
- System/360 compatible family
- Operating System/360
- Solid Logic Technology
- System/360 Model 67/Time-Sharing System
- One-transistor memory cell
- Cache memory
- Relational data base
- First all-monolithic main memory
- Thin-film recording head
- Floppy disk
- Tape group code recording
- Systems Network Architecture
- Federal cryptographic standard
- Laser/electrophotographic printer
- First 64K-bit chip mass production
- First E-beam direct-write chip production
- Thermal Conduction Module
- 288K-bit memory chip
- Robotic control language

Bill -
It's a tough choice, but I'd go with relational data base. It's a software development that's making a big impact.
Dick

PARTS

PARTNO	PNAME
P107	BOLT
P113	NUT
P125	SCREW
P132	GEAR

SUPPLIERS

SUPPNO	SNAME
S51	ABC Co.
S57	XYZ Co.
S63	LMN Co.

PRICES

PART#	SUPP#	PRICE
P107	S51	0.59
P107	S57	0.65
P113	S51	0.25
P113	S63	0.21
P125	S63	0.15
P132	S57	5.25
P132	S63	7.50

Figure 1. *Relational data base consisting of three tables.*

WHICH SUPPLIERS HAVE PARTS FOR LESS THAN $0.50?

SQL QUERY

USER INPUT:

```
SELECT PART#, PRICE, SNAME
FROM   PRICES, SUPPLIERS
WHERE  SUPP# = SUPPNO
       AND PRICE < 0.50
```

QBE QUERY

USER INPUT: DRAW PARTS, SUPPLIERS, SKELETON

COMPUTER-GENERATED TABLES AND USER INPUT:

SUPPLIERS	SUPPNO	SNAME
	_Sn	_Na

PRICES	PART#	SUPP#	PRICE
	_Pt	_Sn	_Pr <0.50

P.	_Pt	_Pr	_Na

RESULTS

PART#	PRICE	SNAME
P113	0.25	ABC Co.
P113	0.21	LMN Co.
P125	0.15	LMN Co.

Figure 2. *An example of using IBM's very-high-level data base languages, SQL and QBE, to satisfy a request involving two tables from Figure 1. The SQL commands are expressed in a standardized block format; an example of the most common form for extracting data is:*

SELECT	some data (column names)
FROM	some file (table names)
WHERE	certain conditions, if any, are to be met (rows)

QBE is initiated simply by typing the table name on the display screen, and the screen returns a skeleton table with column names in it. In this example, the user builds a new table in the blank skeleton by typing "example elements" (e.g., _ Pt) under existing tables and in the blank skeleton. The example elements are formed by typing an underline followed by any mnemonic the user desires. Note that "P." simply means to present the results.

With business information growing at the rate of two file drawers per office worker per year, and with increasing amounts of it stored in electronic data bases, new techniques are required to allow easy, yet controlled, access by workers who lack computer expertise.

Starting in 1970, IBM researchers formulated, implemented, and tested prototype relational data base systems. This new approach in data base processing virtually eliminates the need for computer experience among users.

The relational model opened the way to more flexible, easy-to-use data base systems. The two relational data base management systems marketed by IBM for intermediate and large computer systems—Structured Query Language/Data System, introduced in 1981, and IBM DATABASE 2, introduced in 1983—allow users to update, retrieve, insert, delete, and otherwise manipulate data merely by specifying *what* they want to do, without having to tell the computer *how* to do it.

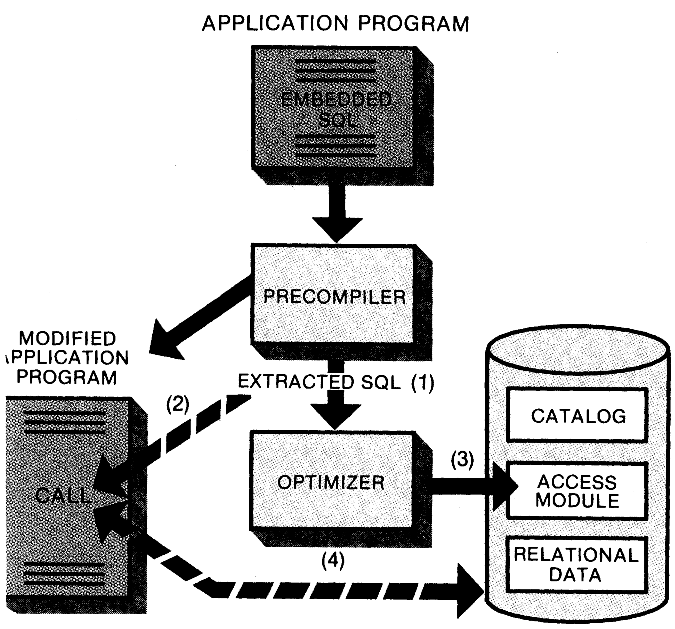
These relational systems are especially "friendly" because of the familiar, easy-to-interpret manner in which users see the data—as two-dimensional, rectangular tables ("relations"), with all information arranged in columns and rows.

IBM developed two very-high-level languages, Structured Query Language (SQL) and Query-By-Example (QBE), to access the relational data bases. Both are easy to learn, easy to apply, and immensely powerful. The innovative concept of QBE, which had a significant influence on display-screen interfaces, uses a two-dimensional programming approach. All queries are made directly onto a blank "skeleton" table appearing on a display screen. The user extracts data by a fill-in-the-blanks mode. SQL is a linear language that comes very close to "speaking English." It may be used both by ad hoc users at terminals and by programmers to embed SQL statements in application programs.

The non-navigational nature of the relational data base model endows QBE and SQL with extreme flexibility. Since there are no predefined information pathways to negotiate, the user is free to make all manner of ad hoc queries—an essential feature for applications where information needs change rapidly.

One of the most important IBM innovations in relational data base technology was a compiler approach to execute SQL statements. Replacing an interpretive approach, this compilation technique reduces the overhead cost of implementing the SQL language by using a precompiler to generate a tailored data access routine before execution time. The access routine, because it is tailored to one specific program, and is reusable, runs much more efficiently than a generalized interpreter.

In addition, the compilation technique uses a very sophisticated optimizer, which chooses economical access paths to the data. The compiler approach allows data base query in a high-level, easy-to-use language, yet also provides efficient program execution.



ꟳigure 3. *The compiler approach is the key to IBM's efficient execution of SQL (very-high-level relational data base language) statements. This diagram illustrates the execution of application programs with embedded SQL statements. Programs are first processed by a precompiler, which extracts SQL statements from the application program (1). The precompiler also replaces the SQL statement in the host program with a CALL to the access routine (2). By very sophisticated analysis of available paths to the data, the optimizer chooses an economical path for the specific SQL statement, which is implemented as an access module (3). When the programs are executed, all the access modules for that program are loaded to provide targets for the modified CALLS (4).*

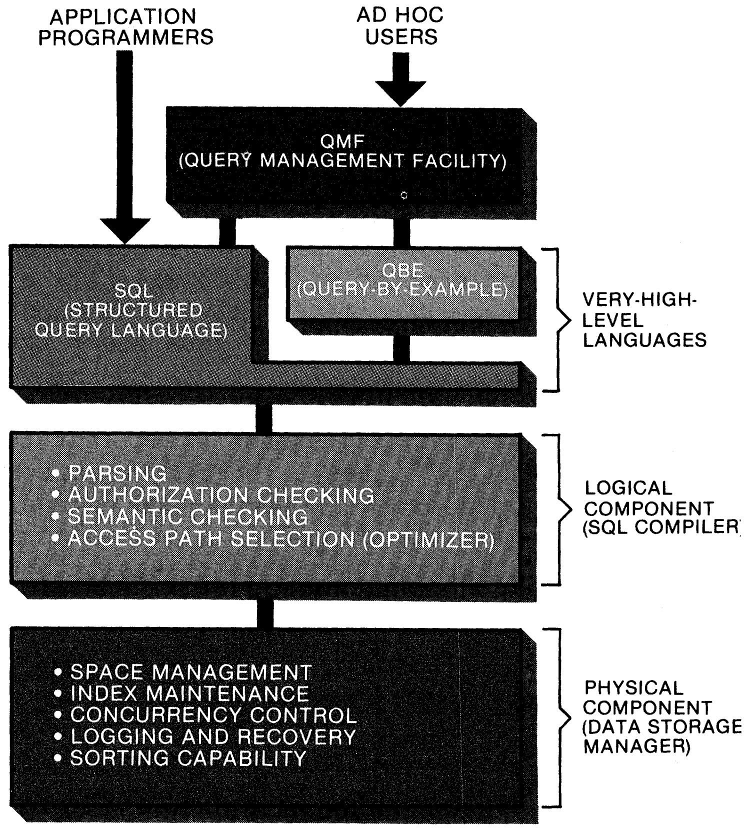


Figure 4. *This generalized architecture is the basis for IBM's relational data base products. It enables different types of users to access data easily, and yet is designed to handle complex programming tasks efficiently while providing the full function of a data base management system.*

Many scientists and programmers throughout IBM contributed to the development of relational data base technology, and researchers continue to explore future applications for the office environment and network users. These contributions are only part of IBM's continuing commitment to research, development, and engineering. IBM®

For free additional information on relational data base, please write: IBM Corporation, Dept. 813D/3N35 Old Orchard Rd., Armonk, N.Y. 10504

SCIENCE/SCOPE

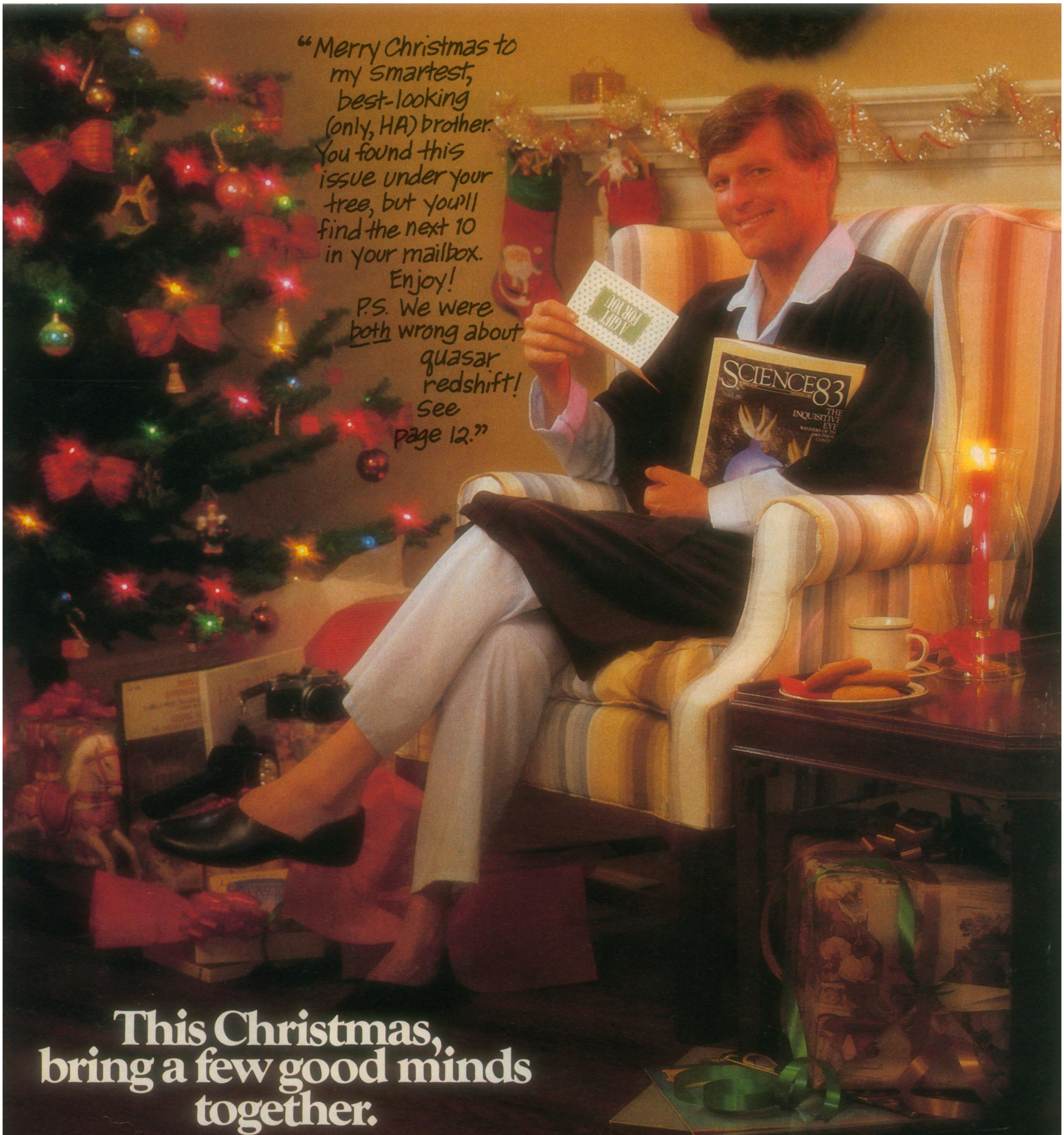
Very High Speed Integrated Circuit technology will be introduced in a system that lets U.S. Army and Marine Corps units automatically report navigation data and their locations to command centers. Hughes Aircraft Company VHSIC chips will be used in the Position Location Reporting System. The chips will significantly increase communications and encoding capability, and reduce vulnerability to jamming. The VHSIC program is being conducted by the Department of Defense to develop chips that will give military electronic systems a tenfold increase in signal processing capability. The high-speed, compact VHSIC chips will be more reliable and will require less power than integrated circuits now in use.

Seven of every 10 commercial communications satellites now in service throughout the world -- including the first four to be launched from the space shuttle -- were built by Hughes. Those four were SBS-3 for Satellite Business Systems, two Anik-C's for Telesat Canada, and Palapa-B for Perumtel of Indonesia. All are based on the HS-376 model, a drum-shaped satellite with an outer panel of solar cells that drops down when in orbit to provide extra power. Nine customers have ordered 27 spacecraft to date. Others include Australia, Brazil, Mexico, American Telephone & Telegraph, Western Union, and Hughes Communications.

A uniquely shaped waveguide antenna is one of 13 patentable innovations built into the Advanced Medium-Range Air-to-Air Missile. The antenna is configured to occupy a very small space and yet provide a low-frequency-band data link to launching aircraft. Its novel shape also minimizes interference and provides a moderate amount of cross-polarization, a feature that improves communications. Hughes designed and developed AMRAAM for the U.S. Air Force and Navy.

Computers are boosting productivity in the electronics business in many ways. At Hughes, for example, one system saved untold time and money in the design of a heat exchanger casting. The computer prepared engineering drawing dimensions and tolerance data in far less time than manual methods. Then, in simulating how numerical control machines would prepare the casting, it discovered the device would have been destroyed in one phase of manufacturing. Engineers thus were able to redesign the item even before a prototype was built.

"Diversification" characterizes Hughes Industrial Electronics Group, located in the Southern California communities of Carlsbad, Irvine, Newport Beach, Sylmar, and Torrance. Our facilities are like small companies with 500 to 2,500 employees, but each offers the resources and benefits of a multibillion-dollar company. Our diverse technologies include silicon and GaAs semiconductors, fiber optics, microwave and millimeter-wave communications, microprocessors, lasers, and solar cells. Send your resume to B.E. Price, Hughes Industrial Electronics Group, Dept. SE, P.O. Box 2999, Torrance, CA 90509. Equal opportunity employer.



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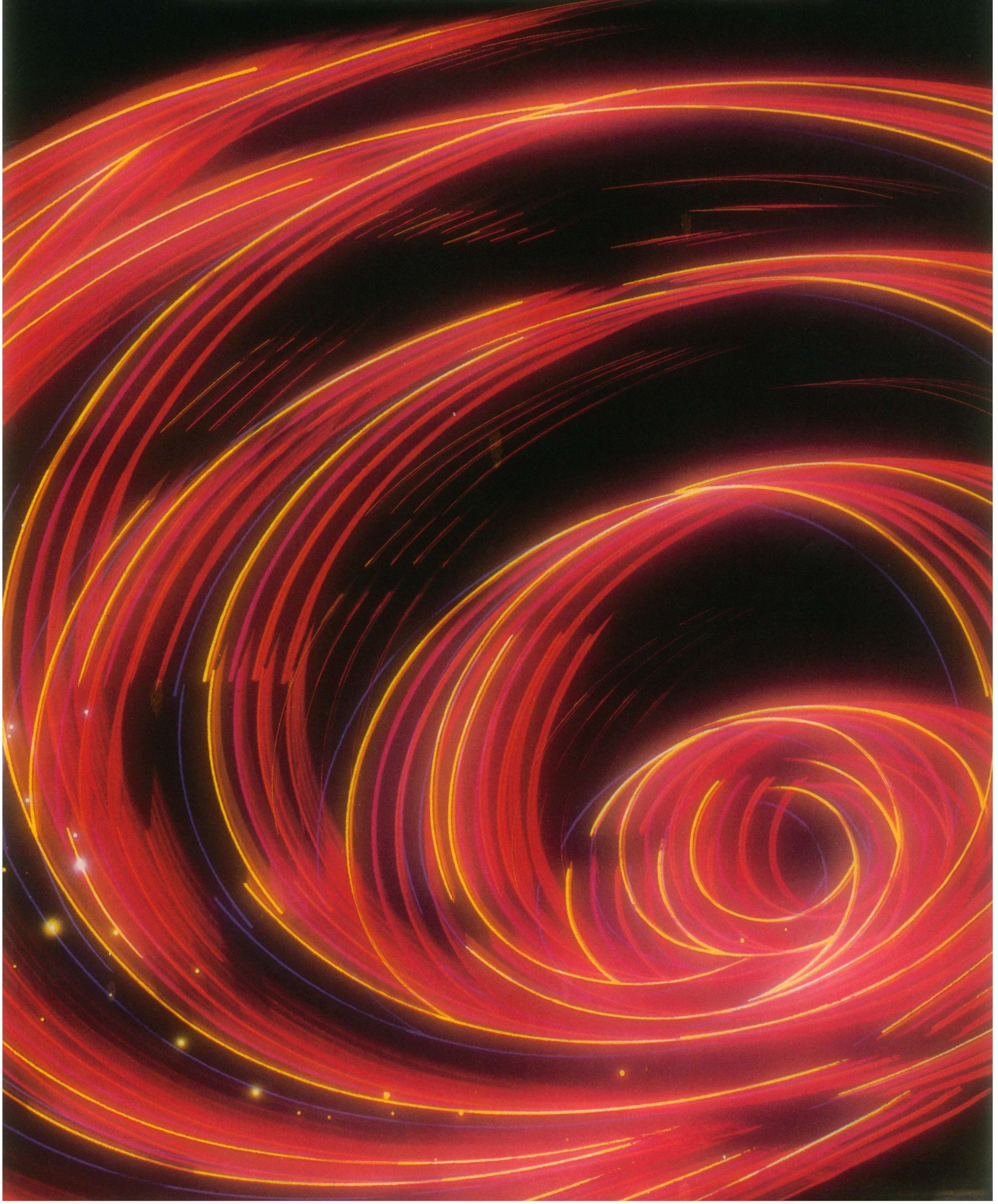
The Illuminated Vortex



The Illuminated Vortex

Understanding how the in-cylinder flow of the fuel-air mixture is influenced by chamber geometry provides a key to improving engine performance. By applying a laser measurement technique, a researcher at the General Motors Research Laboratories has gained new insight into the behavior of the flow.

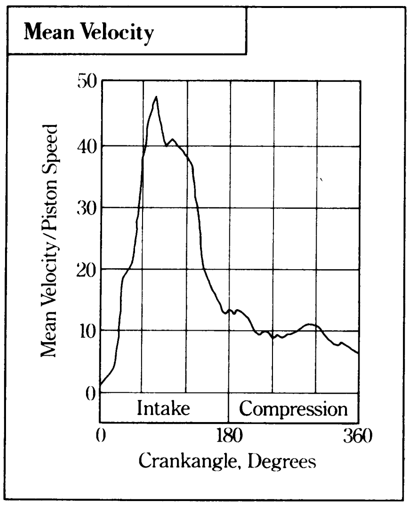
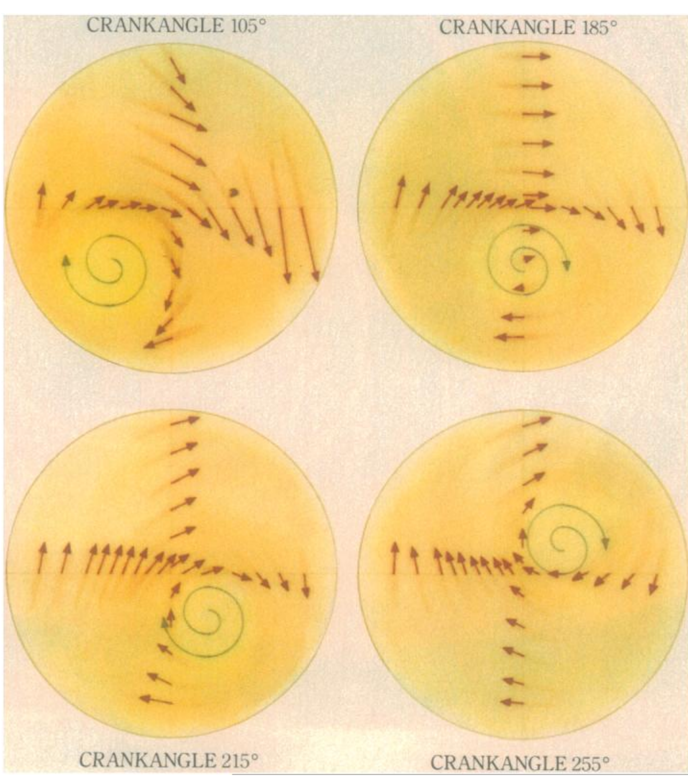


Figure 1: History of mean velocity at a single engine location.

Figure 2: Panoramic view of engine flow patterns. With changing crankangle, the center of rotation precesses from the cylinder's lower left quadrant to its upper right quadrant.



THE FLUID motions inside engine cylinders have considerable influence over the progress of combustion. Mixing of air and fuel, combustion rate, and heat losses from the cylinder are all important transport processes strongly dependent on fluid motions. The motion inside the cylinder has two components. Mean velocity influences the transport of momentum, energy, and species on a cylinder-wide scale, while the turbulence component influences the same phenomena on a local basis. The in-cylinder flow field depends primarily on the geometry of the cylinder and inlet port. Hence, decisions made in the engine design stage exert a controlling influence over the flow. But before questions about how different geometrical features affect the flow field can be answered, the problem of how to measure the flow must be solved. By applying Laser Doppler Anemometry (LDA), Dr. Rodney Rask, a researcher at the General Motors Research Laboratories, has obtained detailed measurements of the flow field.

LDA is a technique in which two focused laser beams pass into the cylinder through a quartz window. In the minute measuring region where the laser beams cross, a regular pattern of interference fringes is created. As the 1-micron particles, which have been added to the engine inlet flow, cross the measurement region, they scatter light in the bright fringes. In Dr. Rask's LDA system, the scattered light is collected by the same lenses used to focus the laser beam, and measured by a photomultiplier tube. The resulting signal is processed electronically to determine the time it takes a particle to traverse a fixed number of fringes. Since the fringe spacing is a known function of the laser beam crossing angle, this transit time provides a direct measure of velocity.

During operation of the LDA, measurements of velocity as a function of engine rotation (crankangle) are made at a number of locations within the cylinder. The instantaneous velocity at each point must then be separated into mean and turbulence components. The simplest technique is to declare that the mean velocities for all cycles are identical and ensemble average the data. However, this approach ignores the cyclic variation in the mean velocity. Another technique looks at individual cycles and uses a variety of methods, including sophisticated filtering, to split the instantaneous velocity into its components. This approach is consistent with the LDA measurements, which clearly show that the mean velocity does not repeat exactly from one engine cycle to the next.

Differences in the flow field from one cycle to the next can seriously compromise engine efficiency. Near the end of the compression stroke, it is important to maintain a consistent velocity at key cylinder locations (e.g., at a spark plug). Dr. Rask's LDA measurements have identified design features that control cyclic variability.

FIGURE 1 shows mean velocity measured at a single location during an engine cycle. High velocity exists during the intake stroke when the inlet flow is rushing through the narrow valve opening. This jet-like flow into the cylinder causes large velocity differences between adjacent cylinder locations and produces strong turbulence. As the end of the intake stroke is approached (180 degrees in Figure 1), the levels of both mean velocity and turbulence drop rapidly. This decrease is a result of the changing boundary conditions for the cylinder—from strong inflow to no inflow. During the compression stroke the flow field evolves, but it undergoes no drastic changes. However, in a high-squish chamber, where the flow is forced into a small bowl in the piston or cylinder head, considerable turbulence is generated near the end of the compression stroke.

Measurements from many cylinder locations are necessary to make the flow field understandable. Figure 2 shows four flow patterns covering a period from near the end of intake into the compression stroke. Note the strong vertical flow, with the center of the vortex away from the cylinder center and precessing with changing crankangle.

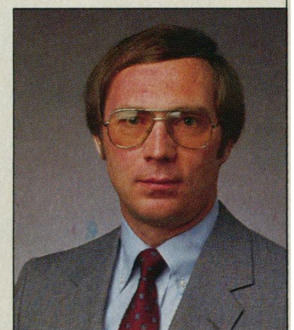
By experimenting with geometrical variables, Dr. Rask has gained new understanding of phenomena observed in operating engines. The resulting knowledge has guided the design and development of new engines with a minimum of trial-and-error testing. The LDA findings are also being used to validate and calibrate engine flow computer models under development.

"From our measurements," Dr. Rask states, "we have been able to deduce how changes in the geometry of the port and combustion chamber modify the velocity field. These flow field effects are now being used to help designers tailor engine combustion for optimum performance."

General Motors

MARK OF EXCELLENCE

THE MAN BEHIND THE WORK



Dr. Rodney Rask is a Senior Staff Research Engineer in the Fluid Mechanics Department at the General Motors Research Laboratories.

Dr. Rask received his undergraduate and graduate degrees in mechanical engineering from the University of Minnesota. His Ph.D. thesis concerned the Coanda effect.

Prior to joining General Motors in 1973, Dr. Rask worked on the design of nuclear reactors at the Knoll's Atomic Power Laboratories. In addition to further refinements in LDA measurement techniques, his current research interests include computer simulation of engine systems, with special emphasis on the intake manifold.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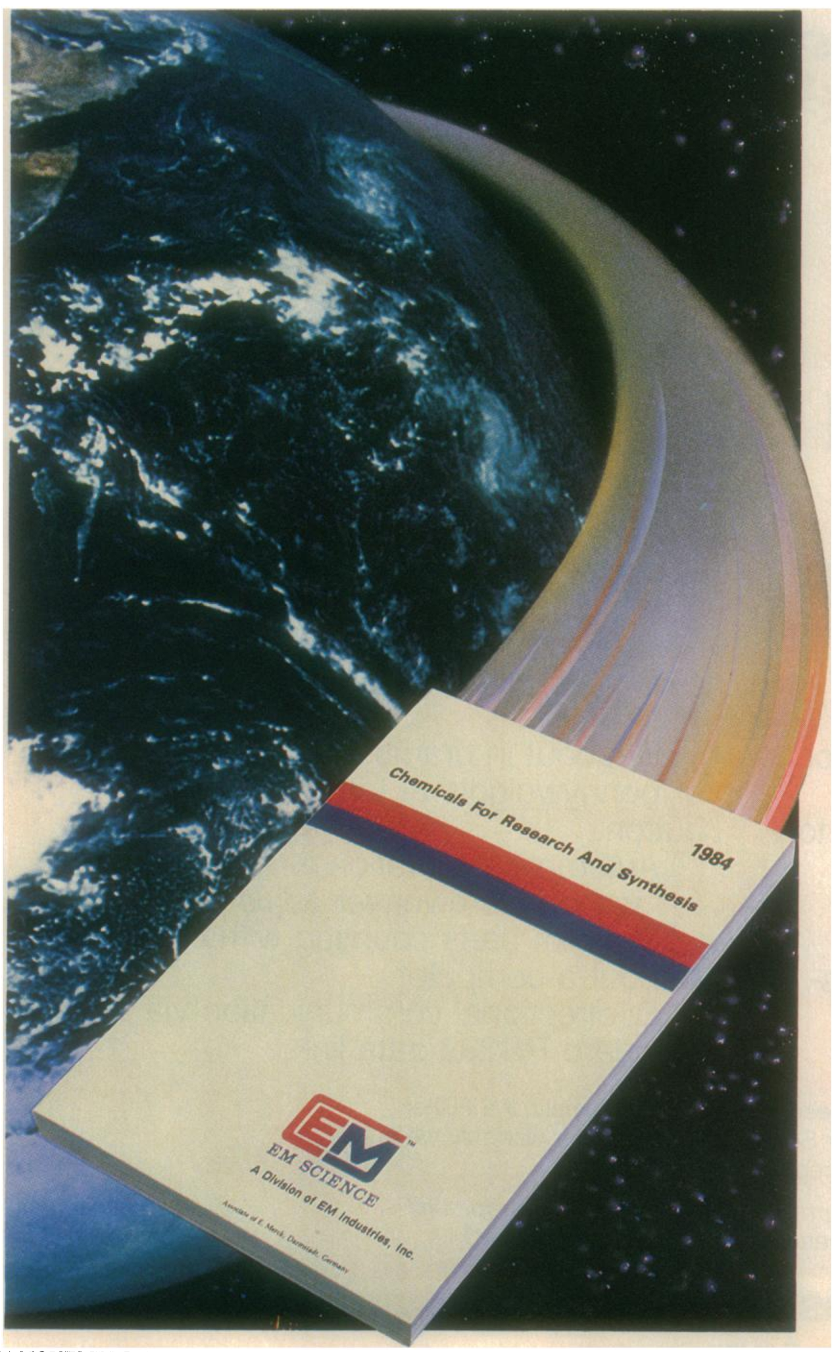

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not improve overall diabetic control further emphasized that the glycemic index should be used in combination with other food attributes (for example, macro- and micronutrient content and overall calories) rather than as the sole criterion for planning diets for diabetics. More recent work, such as the useful studies of Collier and O'Dea showing marked responses of insulin (*4*) and gastric inhibitory polypeptide (*5*) to fat, have served to strengthen this position. On the positive side, we see an important function of the glycemic index in allowing identification of starchy carbohydrate foods that may be incorporated into the higher carbohydrate diets now being recommended in the treatment of diabetes. Such diets have as their goal the reduction of fat intake. With foods that have a low glycemic index, this may be achieved without increasing the postprandial glycemia. Even when diets include very high levels of fat (46.5 grams of butter per 75 grams of carbohydrate), the original glycemic index approach is useful, as demonstrated by the studies of Collier and O'Dea. Thus, despite the addition of fat, lentils, a food with a low glycemic index, still produced an appreciably lower glycemic response than potatoes, a food with a higher glycemic index (*5*).

Our previous work with dietary fiber suggested that a reduction in blood glucose coincided with a reduced rate of carbohydrate absorption (*6*). Our studies with foods and those of O'Dea and coworkers have confirmed that rate of digestion may be a major factor in determining the glucose (*7*) and insulin (*5, 8*) response to starchy foods. Study of the effects on the endocrine response of adding fat and protein to meals is important. However, such studies are complementary to extensive glycemic index testing. This is urgently needed to get an overall picture of the glycemic responses to the many foods that have not been tested and to enable selection of specific foods for more detailed testing and, at a later stage, possible incorporation into therapeutic diets.

THOMAS M. S. WOLEVER
DAVID J. A. JENKINS
Department of Nutritional Sciences, Faculty of Medicine, University of Toronto, Toronto, Canada M55 1A8

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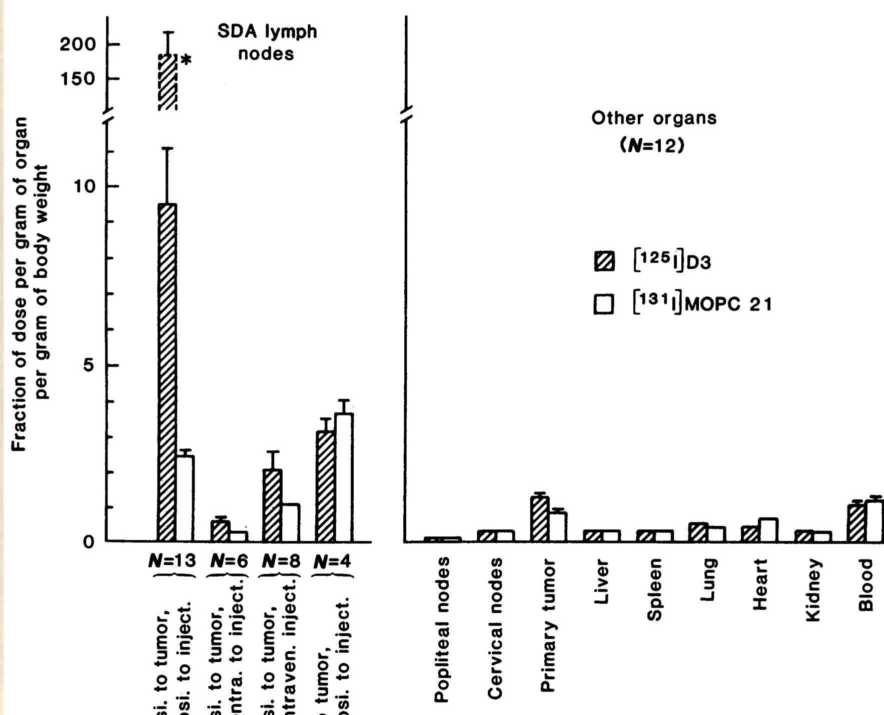
Erratum: In the report "Monoclonal antibodies in the lymphatics: Selective delivery to lymph node metastases of a solid tumor" by J. N. Weinstein *et al.* (28 Oct., p. 423), figure 2 was printed incorrectly. In the bar graph on the left, the captions under $N = 13$ and $N = 4$ were interchanged. The correct figure is printed below.



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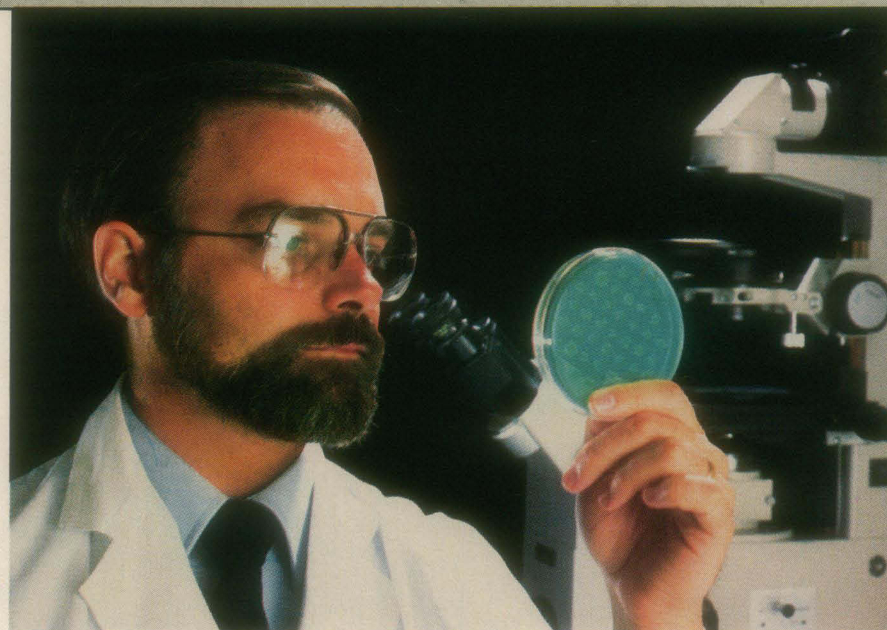

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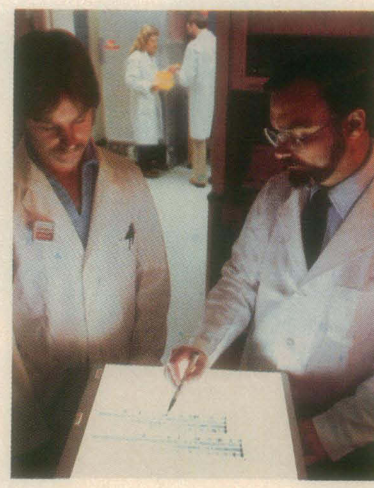

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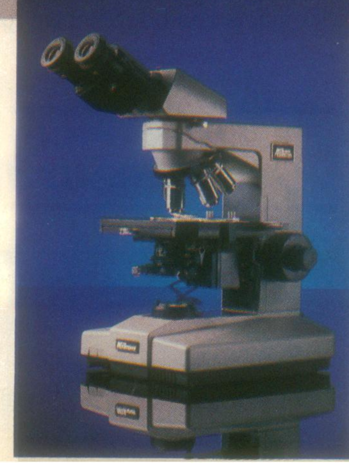

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SCIENCE

Personal Computing in Education and Research

In universities, time-sharing has never been a satisfactory system for using computers. Increased education produces more people who want to use the computer; more users, in turn, produce slower response time and greater waiting time for access. Thus, for any organization that encourages use of the computer, time-sharing becomes unsatisfactory. The development of the microcomputer stimulated thoughts for constructing an alternative system to time-sharing for effective use of computers. A personal computer, or work station, would solve the access problem and would provide uniform response time regardless of the number of users.

At Carnegie-Mellon University, this thinking has led to plans to develop a distributed computer system consisting of small computers connected with each other as well as with larger computers, specialized output devices, and the library—that is, an integrated computer network. This will enable faculty members to have computers in their homes for personal use and for communication with students and colleagues. With such a system, the main computer will be used primarily for problems that require more capacity than is available at the individual work stations. The ultimate aim is to have a personal computer for each student, for all administration and staff members who need one, and for each faculty member who wants one.

Unfortunately, no network exists that can handle the number of computers that we envisage—approximately 8000. A study done jointly with IBM indicated that it would be feasible to construct a network that could handle the expected number. Carnegie-Mellon and IBM have now launched a joint project to develop this network. IBM will have the ownership of the software defining the network and will be able to make the network available to other colleges and universities. Carnegie-Mellon will gain perpetual use of the software. However, no university should be committed to a single company, and although the computers in the Carnegie-Mellon network will be predominantly from IBM, it is our objective that computers from all major vendors be able to coexist within the system.

Since we consider a distributed system to be the computer system of the future for all educational institutions, we have applied to the Carnegie Corporation for a grant to form a consortium of schools that would be involved in the development of software to make effective use of the system. We are optimistic that the consortium will be organized.

In making the transition to the new system, we have deployed a number of the current personal computers throughout the university. Some 550 of these computers will be in use by faculty and students by the end of the academic year and will employ the current time-sharing system for communication. The response from the faculty in fine arts and humanities has been enthusiastic, and they have shown tremendous ingenuity in using the personal computer to help achieve their educational and research goals. Our experience does not justify the fear expressed at many institutions that faculty from these disciplines will reject the computer.

An environment that is densely populated with computers represents a new type of world. We need to know the impact of such an environment on social interactions. We also must study the effects of decisions made by the process of communicating over a network, as opposed to face-to-face meetings. There are, in fact, a large number of issues that require study at the inception of the radical change we are making. As a result, we have created a committee of social and computer scientists to study these and similar important questions as the environment changes.

I believe that this system will have consequences that one day will be looked upon as a revolution in higher education. The key to making this revolution successful is the development of the proper software. The intelligence and ingenuity of all educators will be called upon in the attempt to realize the educational potential of a network of individual work stations.—RICHARD M. CYERT, *President, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213*

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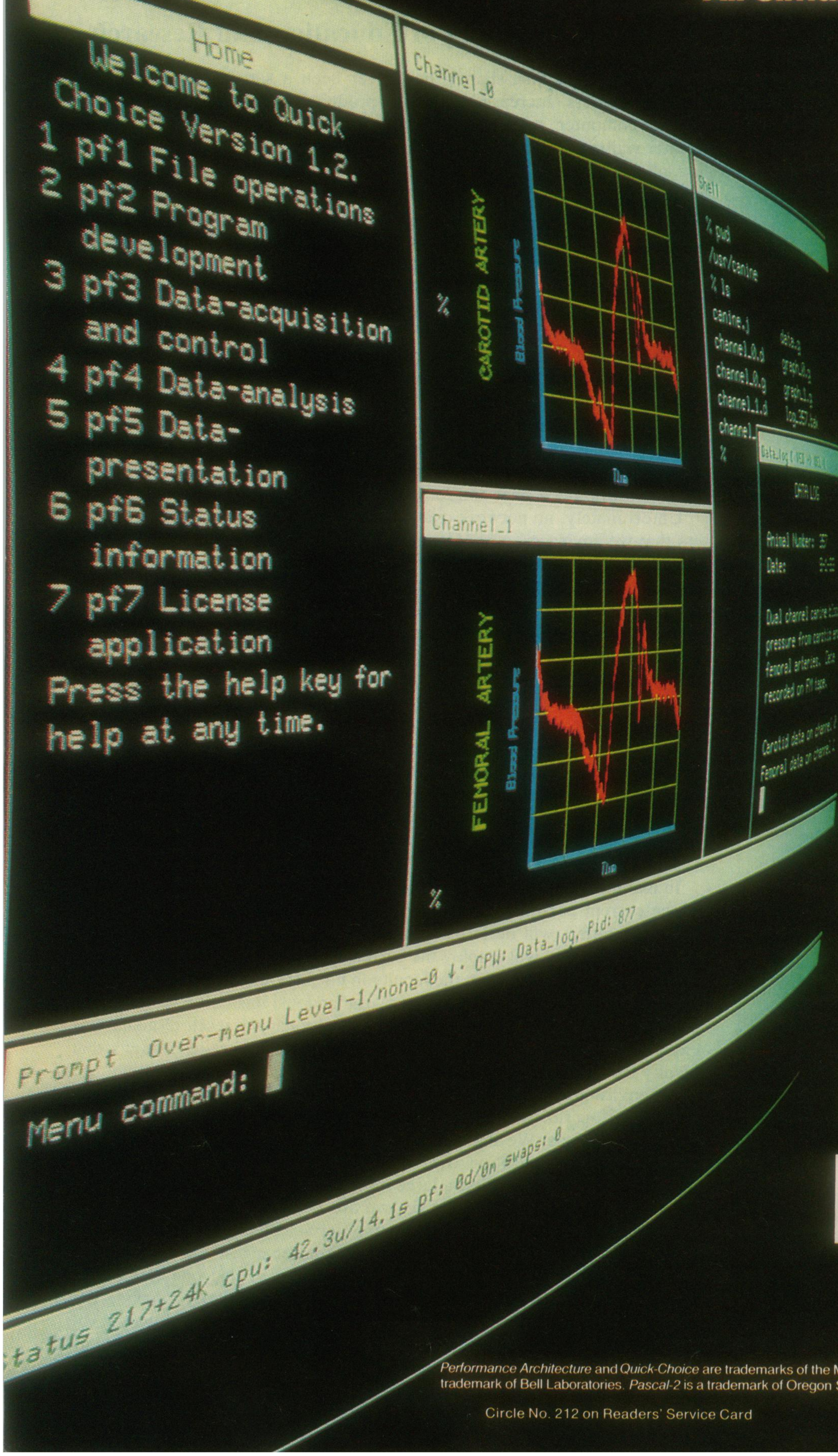

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