10 December 1982 • Vol. 218 • No. 4577 $2.50

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ISSN 0036-8075

10 December 1982

Volume 218, No. 4577

SCIENCE

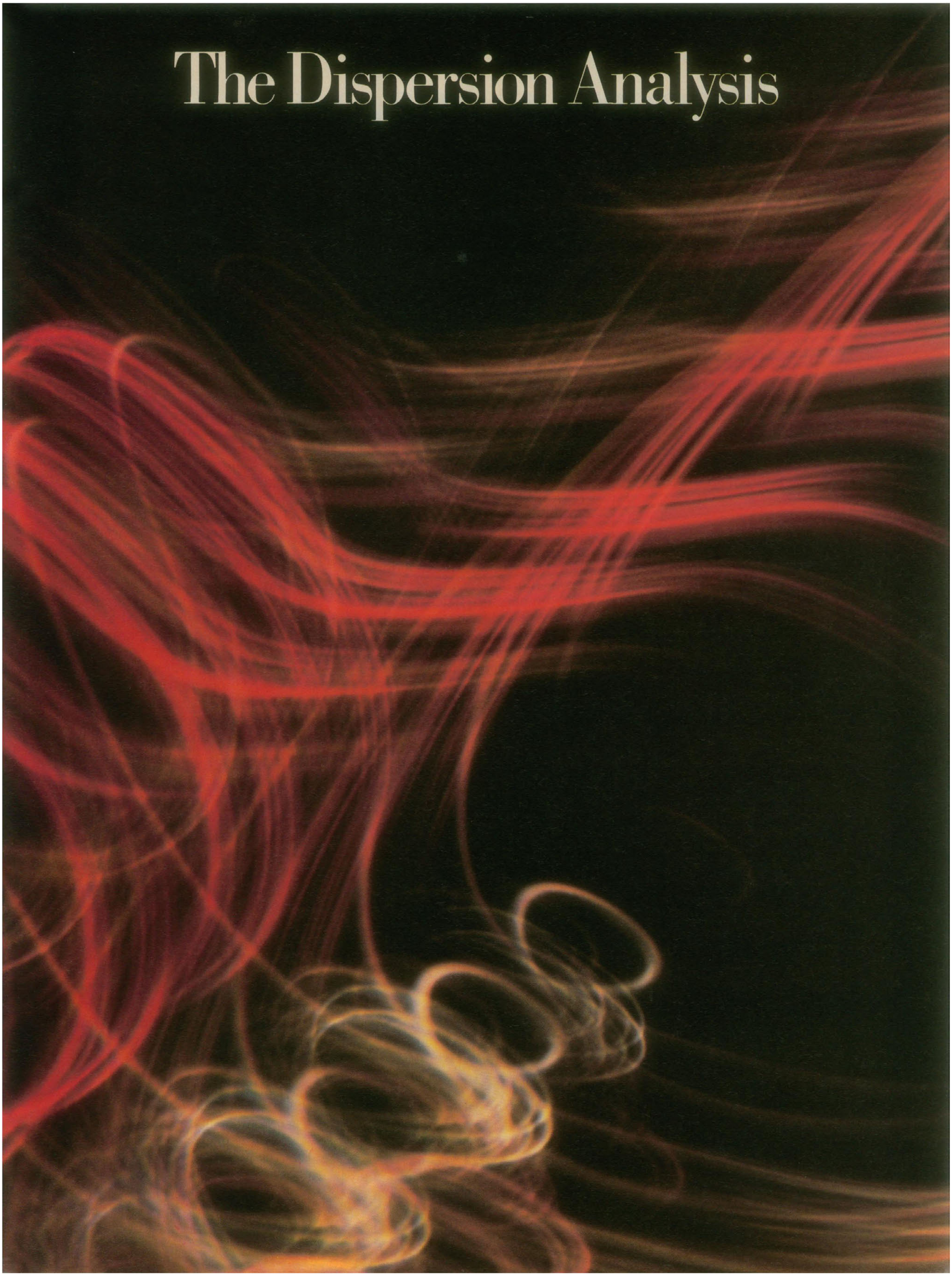
SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with **The Science Monthly**® Copyright © 1982 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): $48. Domestic institutional subscription (51 issues): $85. Foreign postage extra: Canada $24, other (surface mail) $27, air-surface via Amsterdam $55. First class, airmail, school-year, and student rates on request. Single copies $2.50 ($3 by mail); back issues $3 ($3.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Venus flytrap in its native habitat in the sandy, mineral-poor soil of North Carolina's Green Swamp. The species, which is a candidate for endangered species status, is often sold as a novelty because of its rapid leaf movements which are due to very rapid acid growth. See page 1120. [S. E. Williams, Boyce Thompson Institute for Plant Research, Cornell University, Ithaca, New York 14853]

The Dispersion Analysis



The Dispersion Analysis

Exhaust dispersion near a roadway is influenced by the turbulence and heat generated by moving vehicles. Findings at the General Motors Research Laboratories have provided a new understanding of the dispersion process.

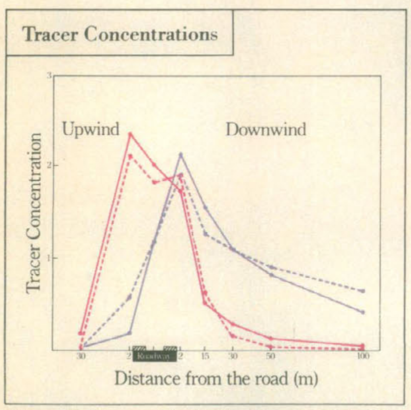


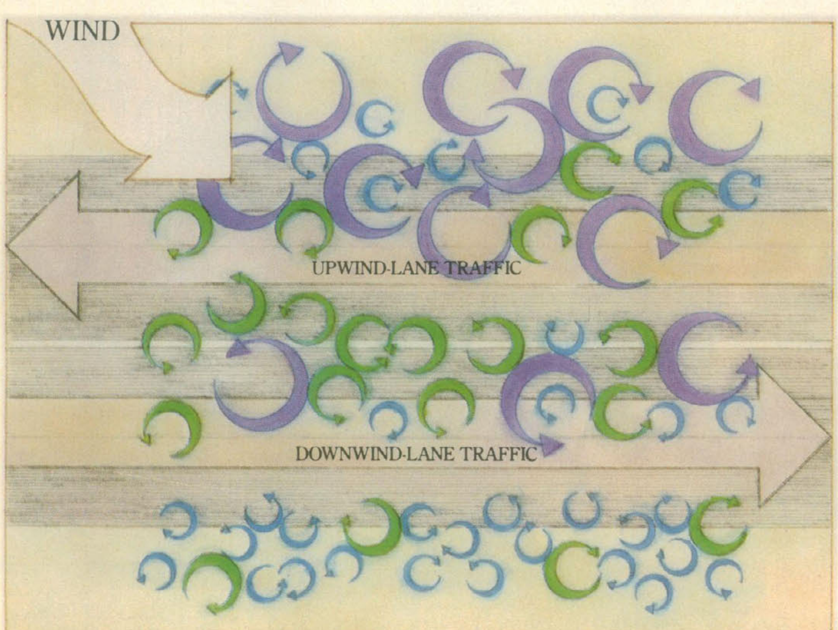
Figure 1: Observed (solid lines) and predicted (dashed lines) tracer concentrations near ground level as a function of distance from the edge of the road. Blue lines indicate the case in which the wind is perpendicular to the road; red lines, when the wind is nearly parallel to the road and opposing the upwind-lane traffic.

Figure 2: This representation of a roadway viewed from above shows the location of large vortices formed by local wind shear when the wind opposes the upwind-lane traffic.

BY USING the conservation-of-mass equation, one can describe the dispersion of gaseous molecules in the atmosphere. The equation includes terms for advection, diffusion, sources and sinks. Advection is the transport of air parcels by the mean wind; diffusion is due mainly to turbulent mixing. But the equation is useful only if we have information about the wind and temperature fields in the atmosphere. Specifically, our ability to predict vehicular exhaust concentrations near a road depends on knowledge of the effects of vehicles on these fields.

The conservation-of-mass equation for the mean concentration of any species, C, is

$$\underbrace{\frac{\partial C}{\partial t}}_{\text{Local rate of change}} + \underbrace{\sum_i \frac{\partial (U_i C)}{\partial x_i}}_{\text{Advection}} = \underbrace{\sum_{i,j} \frac{\partial}{\partial x_i}\left(K_{ij}\frac{\partial C}{\partial x_j}\right)}_{\text{Diffusion}} + \underbrace{So}_{\text{Sources}} + \underbrace{Si}_{\text{Sinks}}$$



where U_i is the mean wind velocity and K_{ij} is the eddy diffusivity tensor. This equation applies when the length scale of mixing is small compared to that of the variation of the mean concentration. Near a road, this condition is met if the averaging time for the concentration and wind velocity is much longer than the time interval of vehicular passage. For a straight roadway, a long averaging time allows one to assume spatial uniformity in the direction parallel to the road, and to ignore the spatial derivatives in that direction.

The input information for K_{ij} and the mean crossroad and vertical wind components near a roadway became available as a result of a large-scale experiment conducted by the General Motors Research Laboratories. The experiment has provided an understanding of the influence of moving vehicles on mechanical turbulence and buoyancy near a roadway. Dr. David Chock was responsible for the design of the experiment and the analysis of the data. The experiment, which duplicated a heavily traveled, level roadway, was conducted under meterological conditions minimizing dispersion.

Moving vehicles affect the mean crossroad and vertical wind components in the following ways. Vehicles act as an obstacle to the mean wind, causing it to slow and move upward as it approaches the vehicles and downward as it leaves the road. In addition, vehicles release heat, which causes a net upward motion. It was established that the increase in the mean vertical wind component due to the exhaust heat was $(B/U)^{1/2}$, where U is the crossroad wind component.

The buoyancy flux, B, is proportional to the heat emission rate of the vehicles.

Moving vehicles also enhance both turbulence intensity and mixing. To determine how this modifies the eddy diffusivity tensor, K_{ij}, Dr. Chock invoked a "second-order closure" assumption, which relates eddy diffusivity to Reynolds stresses and the gradients of mean wind velocity and mean temperature. Eddy diffusivity was assumed to be the sum of ambient and traffic contributions. To determine the traffic contribution, the length scale of the traffic-induced turbulence was assumed to be comparable to vehicle height—1.5 m.

USING THE vast data base compiled during the experiment, Dr. Chock was able to specify K_{ij} and the mean crossroad and vertical wind components, and solve the equation numerically. To test the model, half-hour measurements of a tracer gas were used to map out experimentally the exhaust dispersion under various meteorological conditions. The case where the wind speed is low and the wind direction is nearly perpendicular to the roadway is represented by the blue lines in Figure 1. Both the model and the experiment show the same dispersion pattern. The peak concentration is on the downwind roadside.

When the wind is nearly parallel to the road, the situation is much more complicated. Figure 2 shows that when the wind and traffic flow on the upwind lanes oppose each other, a high shear region occurs immediately upwind of the first traffic lane. When the wind and traffic are in the same direction, the high shear region occurs in the median of the road. In these high shear regions, large eddies are generated and turbulent mixing is intense. The red lines in Figure 1 show a comparison of the model's predictions with the tracer data for the case illustrated by Figure 2. Notice that the peak concentration can actually occur on the upwind roadside, due to the exhaust transport by these large eddies. Dr. Chock's model is the first to predict this occurrence.

Under all combinations of wind speeds and directions, the predictions based on the model compare favorably with the measured tracer concentrations. There is little systematic bias with respect to wind direction.

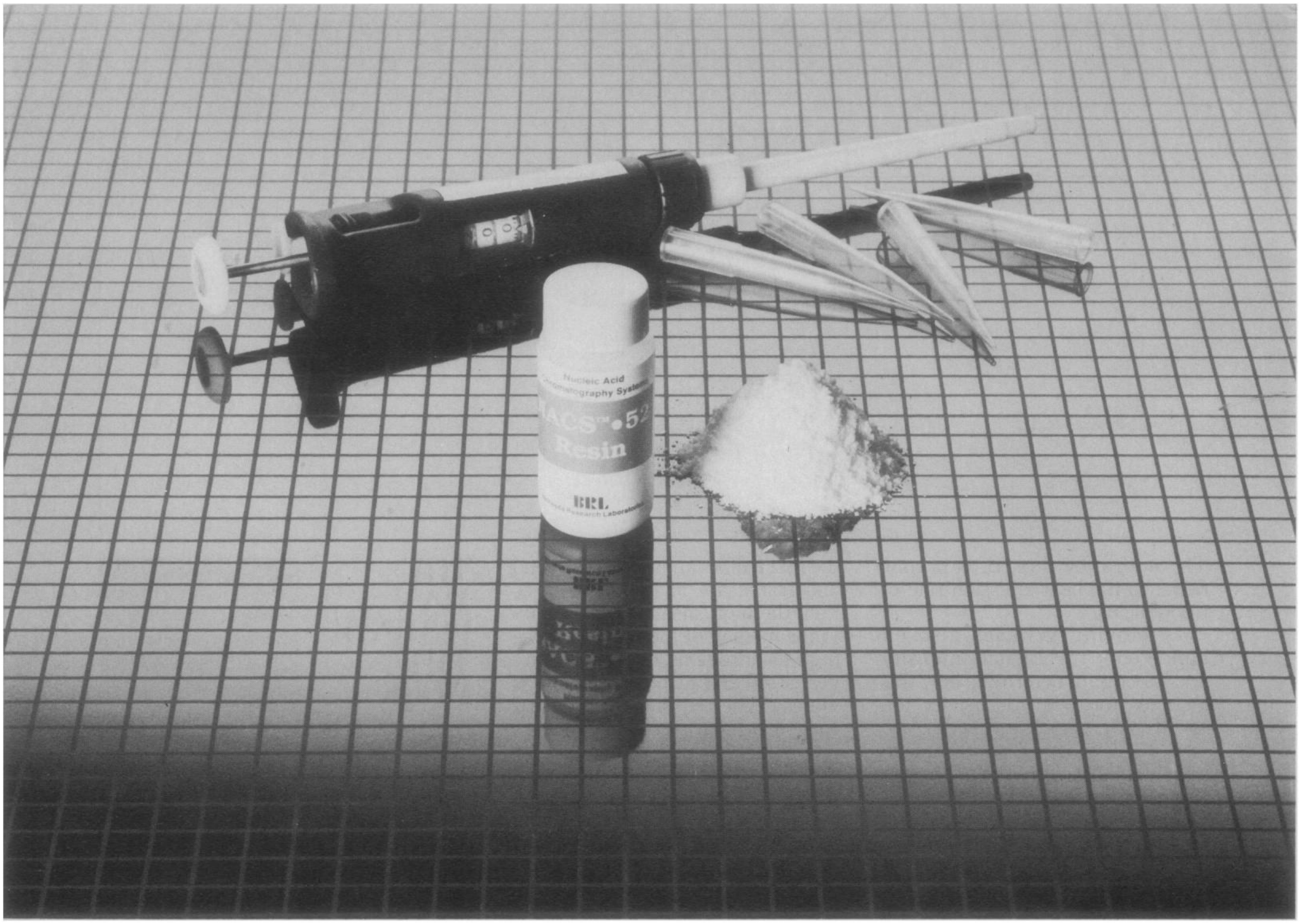
"In light of this new model, exhaust dispersion near a roadway can now be predicted with reliability," says Dr. Chock. "This is of importance for environmentally sound road planning, and opens the door to the investigation of dispersion on city streets, where the presence of tall structures introduces even further complexity."

THE MAN BEHIND THE WORK

Dr. David Chock is a Senior Staff Research Scientist in the Environmental Science Department at the General Motors Research Laboratories.

Dr. Chock received his Ph.D. in Chemical Physics from the University of Chicago. His thesis concerned the quantum mechanics of molecules and molecular crystals. As a Postdoctoral Fellow at the Free University of Brussels, he did research work on the dynamics of critical phenomena. He did additional postdoctoral work in the fields of solid-state physics and fluid dynamics.

Dr. Chock joined the corporation in 1972. He is leader of the GM atmospheric modeling group. His current research interests include the phenomena of atmospheric transport and reactions, and the statistical study of time-series data.



Nucleic Acid Purification 1983

BRL has simplified the art of nucleic acid purification with NACS™—the Nucleic Acid Chromatography System.

Introducing NACS™ a family of four ion-exchange chromatography resins, **designed to provide every research lab with easy-to-use analytical and preparative methods for purifying and analyzing nucleic acids.**

NACS is a complete system which guarantees quality results in the purification of a wide range of nucleic acids: supercoiled DNA • DNA restriction fragments • oligonucleotides • genomic DNA • RNA molecules • separated DNA strands • and large M.W. single-stranded DNA. The gravity flow grade resin is also useful for mini columns/batch methods • gel extraction/electroelution • sample "clean up" • and clone screening.

Today, the art of nucleic acid purification demands simplicity. The NACS system delivers it.

As simple as loading a pipette tip. With the BRL NACS • 52 resin, nucleic acid purification today can be as simple as loading a pipette tip and adding your sample. In just minutes your purification is complete. The simplicity of NACS • 52 saves you time and money.

Proven results. The NACS system guarantees the highest resolution purification of nucleic acids – **whether you are using a simple gravity flow set-up, peristaltic pump or HPLC system.** NACS resins give you excellent recoveries with a high degree of purity and no cross-contamination. And, nucleic acids purified on NACS retain their biological activity.

An applications manual. To ensure successful use of NACS in your lab, BRL has developed the NACS Applications Manual which provides step-by-step protocols and periodic updates for a wide range of NACS applications. The manual is included with each NACS Starter Kit.

To learn more about NACS. BRL invites enquiry on all aspects of this remarkable new system. For a complete description of the NACS system and specific applications, please call our Technical Services Department. An illustrated 6-page brochure is available on request.

BRL

Bethesda Research Laboratories, Inc.
P.O. Box 6009 • Gaithersburg, MD 20877
Telex: 908750 BRL GARG
To Order: (800) 638-8992;
In Maryland (301) 840-8000
Technical Services: (800) 638-4045

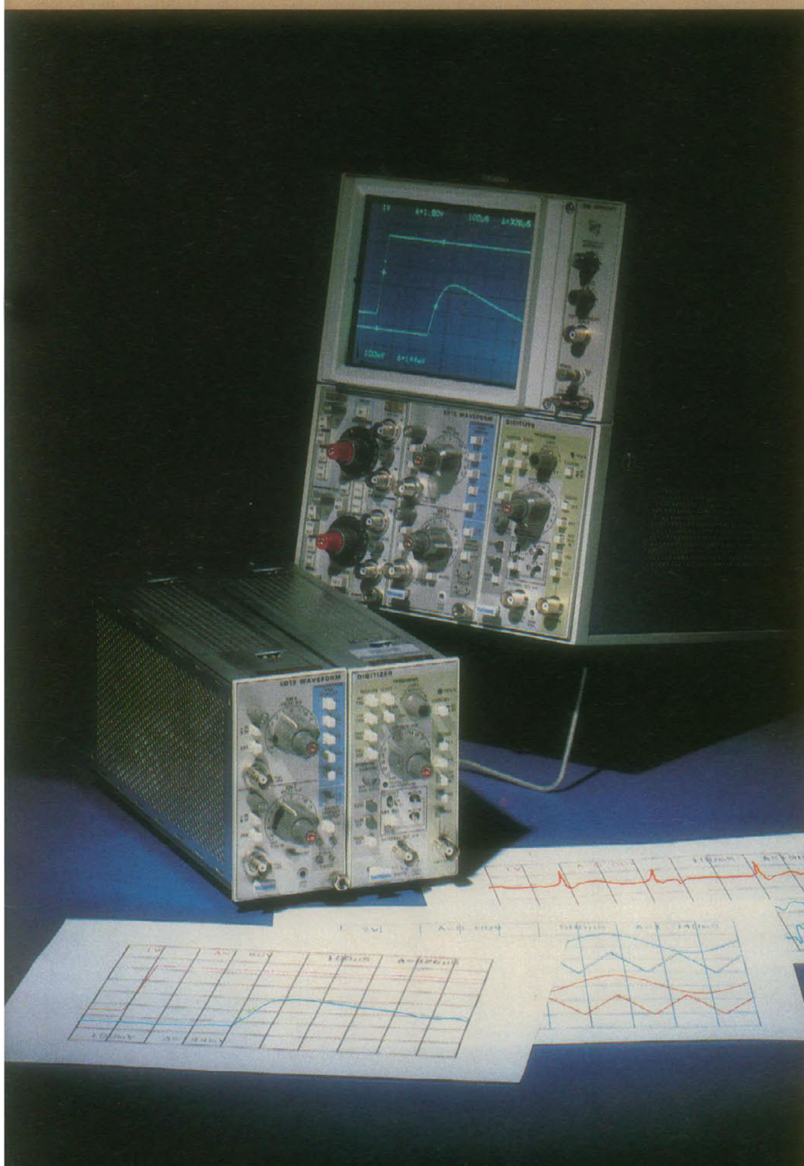
BRL Bethesda Research Laboratories GmbH
Offenbacher Strasse 113
6078 Neu Isenburg • West Germany
Telex: 417699 BRLNI D
To Order/Technical Services: 06102-3206

BRL Bethesda Research Laboratories (UK) Ltd.
P.O. Box 145 • Science Park
Cambridge • CB4 4BE United Kingdom
Telex: 818710 BRLCAM G
To Order/Technical Services: (0223) 315504

Circle No. 327 on Readers' Service Card

TEK 5D10 WAVEFORM DIGITIZER

Introducing a digital storage plug-in for Tek 5000 Series scopes.



Now you can have the benefits of digital storage by the simple addition of the Tek 5D10 plug-in to any Tek 5000 Series scope. The 5D10 is powerful testimony to the long-term value of Tek's unique plug-in concept: nothing else gives you so much capability at an affordable price.

With the 5D10, all critical information is alpha-numerically displayed on the CRT, including instrument settings, cursor values and trigger point. Results are accurate to ±1%. Storage is automatic, for as long as you like. Features such as cursors, pre-trigger and stored reference waveforms help make short work of your measurement tasks.

The 5D10 is a boost to biofeedback analysis. To Visual Evoked Response. To microelectrode based testing. And to scores of other applications. You can record and store multiple waveforms. A choice of nine different amplifiers assures proper signal conditioning. You enjoy automatic measurement while using the familiar Tek 5000 Series scope.

Documentation is easy and complete. Connect the 5D10 to an X-Y recorder or use your existing camera: either way, you automatically obtain vital waveform and CRT readout as part of your records.

Call the toll-free number below for more information on the 5D10. Or talk to your Tek Sales Representative soon. Count on Tektronix to keep you current, at the most reasonable cost, now and in the future.

For further information, contact:

U.S.A., Asia, Australia, Central & South America, Japan
Tektronix, Inc.
P.O. Box 4828
Portland, OR 97208
Phone: 800/547-1512
Oregon only: 800/452-1877

Europe, Africa, Middle East
Tektronix Europe B.V.
Post Box 827
1180 AV Amstelveen
The Netherlands
Telex: 18312

Canada
Tektronix Canada Inc.
P.O. Box 6500
Barrie, Ontario L4M 4V3
Phone: 705/737-2700

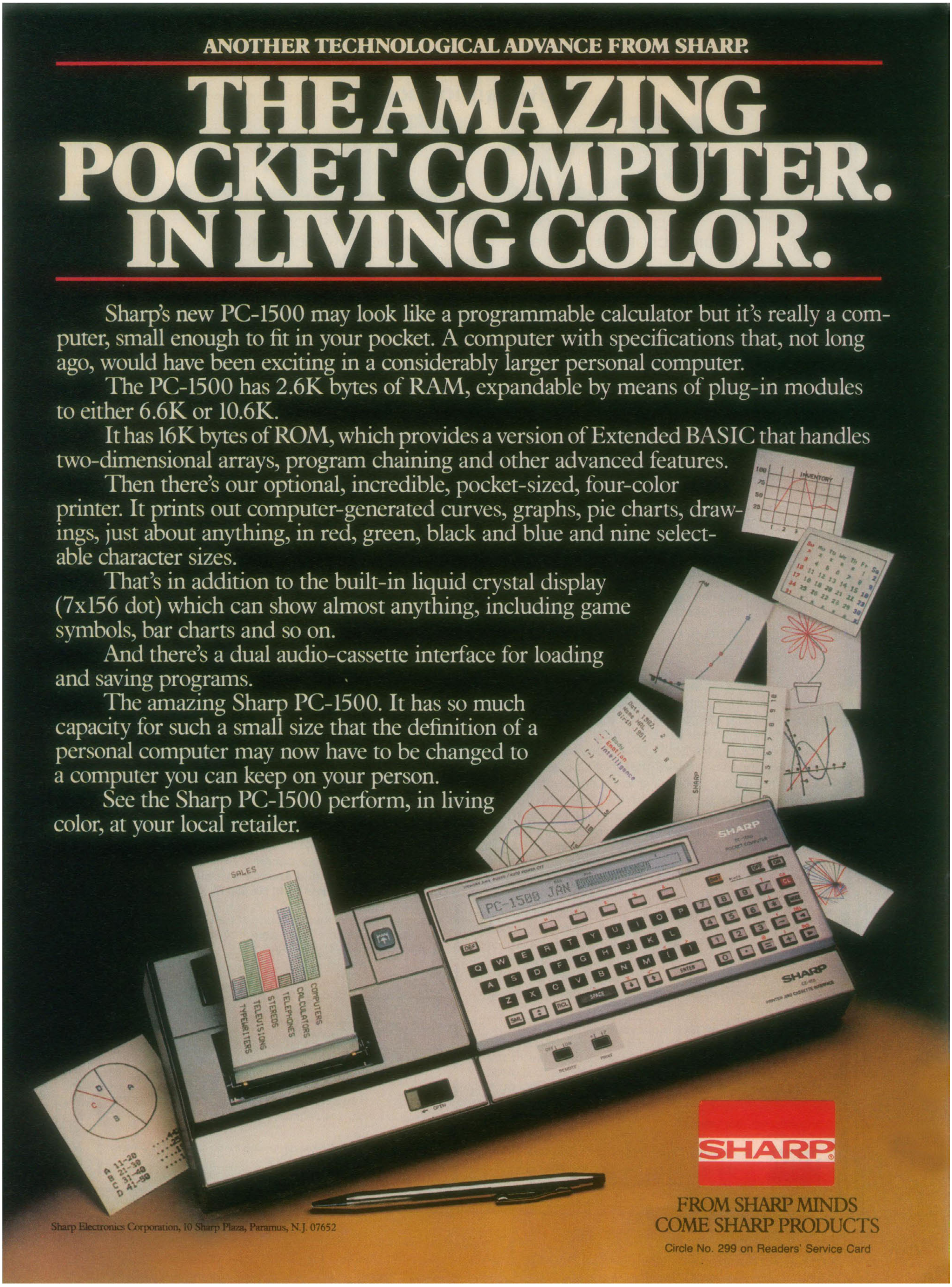
The Answer By Any Measure

Tektronix
COMMITTED TO EXCELLENCE

Circle No. 332 on Readers' Service Card


NALGENE®

The VR-1 is the subject of one or more pending patents.


ANOTHER TECHNOLOGICAL ADVANCE FROM SHARP.
THE AMAZING POCKET COMPUTER. IN LIVING COLOR.
Sharp's new PC-1500 may look like a programmable calculator but it's really a computer, small enough to fit in your pocket. A computer with specifications that, not long ago, would have been exciting in a considerably larger personal computer.
The PC-1500 has 2.6K bytes of RAM, expandable by means of plug-in modules to either 6.6K or 10.6K.
It has 16K bytes of ROM, which provides a version of Extended BASIC that handles two-dimensional arrays, program chaining and other advanced features.
Then there's our optional, incredible, pocket-sized, four-color printer. It prints out computer-generated curves, graphs, pie charts, drawings, just about anything, in red, green, black and blue and nine selectable character sizes.
That's in addition to the built-in liquid crystal display (7x156 dot) which can show almost anything, including game symbols, bar charts and so on.
And there's a dual audio-cassette interface for loading and saving programs.
The amazing Sharp PC-1500. It has so much capacity for such a small size that the definition of a personal computer may now have to be changed to a computer you can keep on your person.
See the Sharp PC-1500 perform, in living color, at your local retailer.
SALES
COMPUTERS
CALCULATORS
TELEPHONES
STEREOS
TELEVISIONS
TYPEWRITERS
PC-1500 JAN
SHARP
Sharp Electronics Corporation, 10 Sharp Plaza, Paramus, N.J. 07652
SHARP
FROM SHARP MINDS
COME SHARP PRODUCTS
Circle No. 299 on Readers' Service Card

Have it your way -

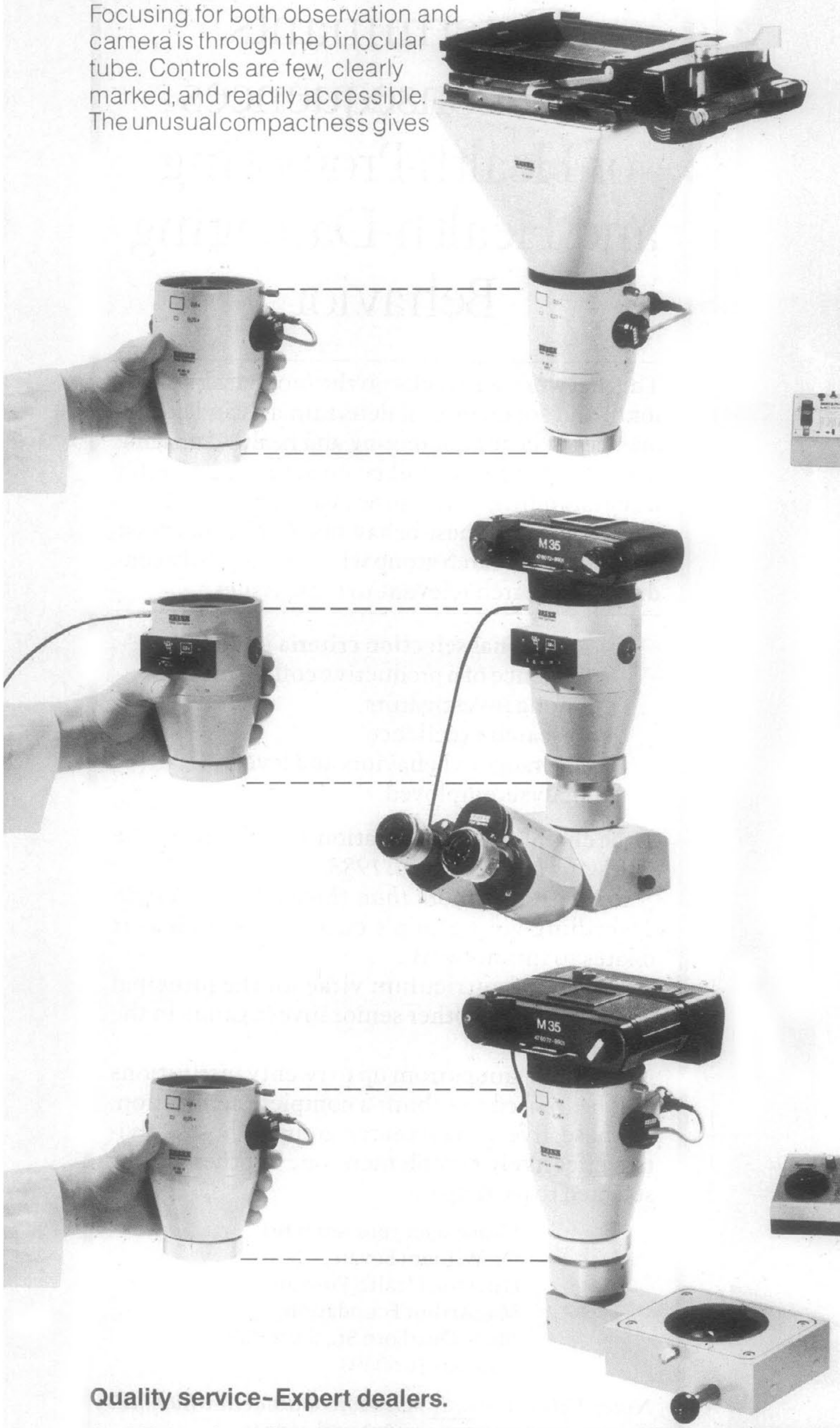
The great name in optics

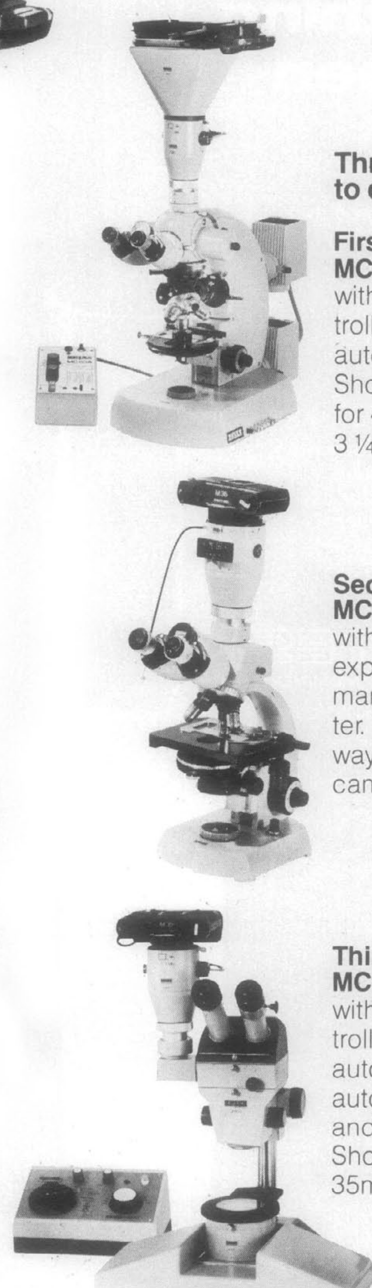
ZEISS

West Germany

for high-quality photomicrography.
Compact, convenient—MC 63 Attachment Camera

It's the small camera with the large field. And it's perfectly human engineered for the utmost convenience. Exposure control is fully automatic. Focusing for both observation and camera is through the binocular tube. Controls are few, clearly marked, and readily accessible. The unusual compactness gives it unequalled stability and freedom from vibration. Accepts both 35mm and 4 x 5″ camera backs.





Three ways to choose from.

First way:
MC 63A
with electronically controlled shutter for fully automatic exposure. Shown with camera back for 4 x 5″ Polaroid® or 3 ¼ x 4 ¼″ film.

Second way:
MC 63C
with built-in automatic exposure control and manually released shutter. The most economical way. Shown with 35mm camera back.

Third way:
MC 63
with electronically controlled shutter for fully automatic exposure, automatic film advance, and manual override. Shown with motor-driven 35mm camera back.

Quality service-Expert dealers.

Carl Zeiss, Inc., One Zeiss Drive, Thornwood, N.Y. 10594. (914) 747-1800. Branches: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D.C. In Canada: 45 Valleybrook Drive, Don Mills, Ontario, M3B 2S6. (416) 449-4660.

For literature circle reader service number 317
For a demonstration circle reader service number 318

10 December 1982, Volume 218, Number 4577

SCIENCE

Decline in Industrial Engineering

As president of a university with a school of engineering and as a director of large manufacturing corporations, I am more and more convinced that the steady decline of some of our major industries, such as steel, automobiles, energy, and mass transportation, is closely related to our lack of competitiveness in engineering in these fields.

Excessively high wages, union work rules, and unreasonable government regulations are usually offered as reasons for the difficulties of these industries. I argue that the quality of management and the quality of engineering are at the root of some of our most serious problems, at least in the crucial fields mentioned above. An excessive proportion of executives are products of business schools and are not technically oriented, and an excessive proportion of our engineers are inadequately trained.

These inadequacies in training begin in our high schools, where the teaching of mathematics and physical sciences is degenerating. Low salaries and low prestige are driving qualified teachers, particularly science teachers, into other fields.

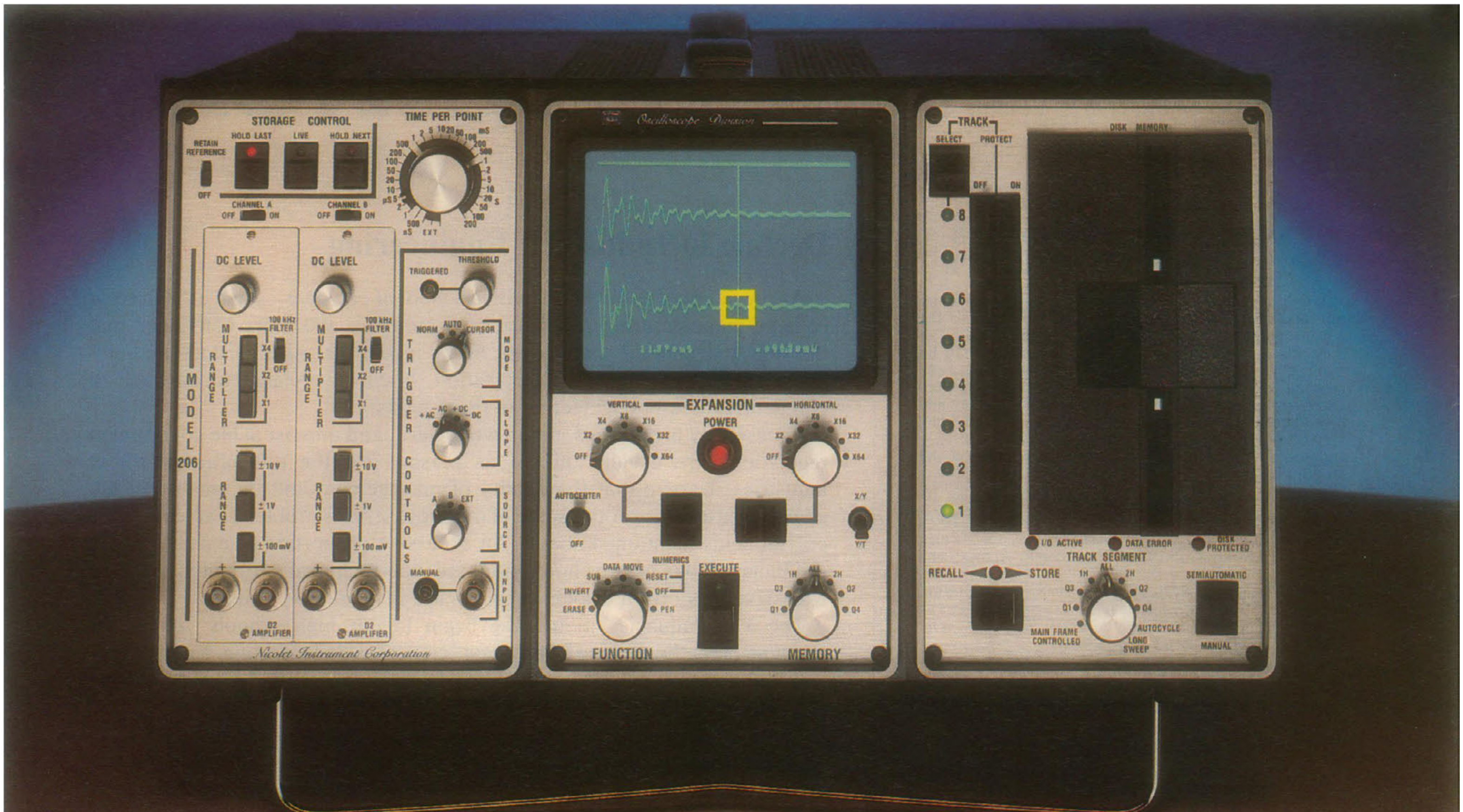
In West Germany, France, Switzerland, Japan, and the Soviet Union, students typically arrive at engineering schools with a solid background in advanced calculus and theoretical physics. They usually have 7 years of postsecondary education before being hired by industry. In the United States, students are hired after only 4 years of college, the first year of which is often remedial, to make up for the deficiencies of our secondary school system. This provides at best only 2 years of training for engineering.

The appetite of industry for engineers at present is such that there is relatively little financial reward in spending a fifth year getting a master's degree or going on to a Ph.D. in engineering. As a consequence, industry receives few people with an advanced education in engineering and the supply of faculty for engineering schools is becoming more and more precarious. While a great deal of educational effort is expended by companies to train recently graduated engineers for their first job, this does not make up for the fact that continuing education for engineers is primitive as compared, for example, to the postgraduate education that hospitals, universities, and medical associations provide for health professionals.

The effects of these shortcomings are already visible. Our nuclear plants are poorly designed, and it is in large part because of this (not just regulatory changes) that there are more and more expensive change-orders. Because relatively little attention has been paid in this country to the probes upon which the cybernetic systems in the steel industry should be based, steel companies are arranging for Japanese engineers to install the process controls that they have been unable to plan internally. Domestic companies seem incapable of engineering such relatively simple projects as subway cars; both New York and San Francisco have selected French cars for their systems. Foreign automobiles, particularly Japanese ones, are preferred by a large part of our population, on the basis not of price but of better design.

At the same time, an Administration that wants to "reindustrialize America" and "rearm America" is eliminating all funds for engineering education and most funds for science education from the budget of the National Science Foundation. The small instrumentation program launched by the Department of Defense and the modest gift program from industry made possible by the new tax laws are not satisfactory substitutes.

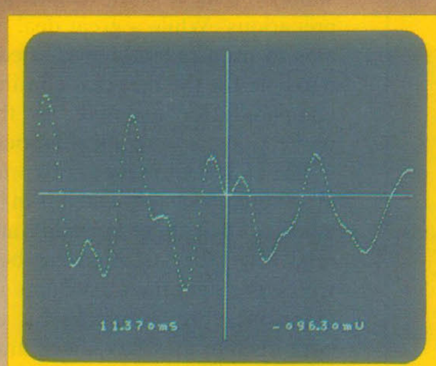
We need to restructure our secondary school science curriculum and make it possible to support engineering schools for a fifth year of training. We need support for training and salary supplementation for mathematics and physics teachers in high schools. We need equipment for both high schools and schools of engineering. Only a massive effort to improve science education in our high schools and engineering education in our universities can keep our young people competitive with young engineers in other advanced industrialized nations.—JEAN MAYER, *President, Tufts University, Medford, Massachusetts 02155*



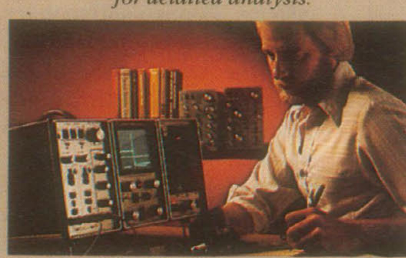
See things you've never seen before.

Nicolet digital oscilloscopes offer you resolution, precision, dynamic range and transient capture capabilities unobtainable on analog oscilloscopes. *They are simple to operate and yet extremely versatile.*

Signals can be viewed live, continuously compared to a reference waveform or stored for detailed examination. Continuous, normal and pre-trigger operation are offered as standard and in all modes cursor-interactive time and voltage coordinates can be displayed concurrently with the signal. Stored waveforms can be displayed or plotted in XY or YT format, transferred to internal disk memory for permanent storage or output to other computing devices via industry standard interfaces.



Expansion of selected area in above photo, for detailed analysis.



In addition to offering you the performance you would expect from the industry leader, Nicolet digital oscilloscopes are extremely well proven with thousands in effective use throughout the world.

Find out how Nicolet can help you solve problems and see things you've never seen before.

For more information, simply circle the reader service card or call 608/271-3333. Or write: Nicolet Instrument Corporation, 5225 Verona Road, Madison, Wisconsin 53711.

NICOLET INSTRUMENT CORPORATION
OSCILLOSCOPE DIVISION

Sales and Service Offices Worldwide

Nicolet Digital Oscilloscopes

For immediate need circle reader service number 301
For literature circle reader service number 302