

17 August 1979 • Vol. 205 • No. 4407

\$1.50

# SCIENCE

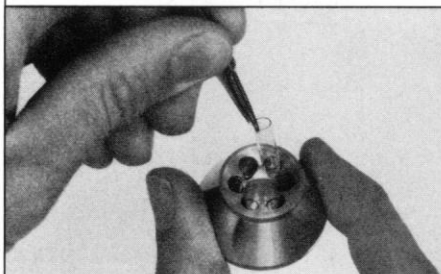
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





# New rotors for the Airfuge®-

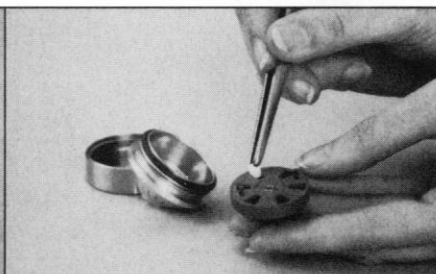
## the small-sample ultracentrifuge.



The new 30° fixed angle rotor holds up to 240  $\mu$ l per tube and provides forces up to 178,000 g.



The new Batch Rotor rapidly pellets 2 to 7 ml of material.



The new Electron Microscopy Particle Counting Rotor is useful for virus research.

The Airfuge® air-driven ultracentrifuge, with its high forces and speeds, is unsurpassed for centrifuging small samples rapidly. The Airfuge continues to grow in versatility. Now there are five rotors to choose from for numerous applications.

Two fixed angle rotors, the 18° and the new 30° rotor, can pellet any material that can be sedimented in a full-sized ultracentrifuge, but in a fraction of the time. The rotors accelerate to a maximum speed of 95,000 rpm in just 30 seconds. They can be used for separations ranging from molecular weight determination studies, binding studies, cellular separations, lipoprotein fractionation, to steroid hormone receptor assays.

The Batch Rotor pellets material in a polyethylene liner or in the rotor body itself. The Electron Microscopy

Particle Counting Rotor sediments particles uniformly onto the surfaces of specimen grids for rapid, accurate, and reliable detection and counting. The unique Chylomicron Rotor clarifies lipemic sera by flotation of chylomicrons in just ten minutes.

The Airfuge ultracentrifuge uses ordinary laboratory air pressure to spin rotors almost friction-free on a cushion of air. It's efficient, quiet, and simple to operate. Ask about the 30-day free trial offer for the Airfuge. For a description of the Airfuge and its applications, write for the new Airfuge brochure, SB-557, to Beckman Instruments, Inc., 1117 California Ave., Palo Alto, CA 94304.

# BECKMAN

# REQUIRED READING THE WORLD OVER

## FOR CHROMATOGRAPHY, ELECTROPHORESIS, IMMUNOCHEMISTRY AND HPLC

The Bio-Rad Catalog has become an invaluable sourcebook in laboratories throughout the world. More than 1,000 research tools are featured in this year's edition of the industry's most comprehensive catalog of materials, equipment and systems for high resolution analysis of biomolecules. A copy of our 1979 edition is yours for the asking.

Techniques featured include new complete systems for electrofocusing, the powerful protein separations technique • new HPLC columns for carbohydrate analysis • DNA sequencing techniques with the "super slab" electrophoresis cell • cell surface labeling with solid phase antibodies — to name just a few.

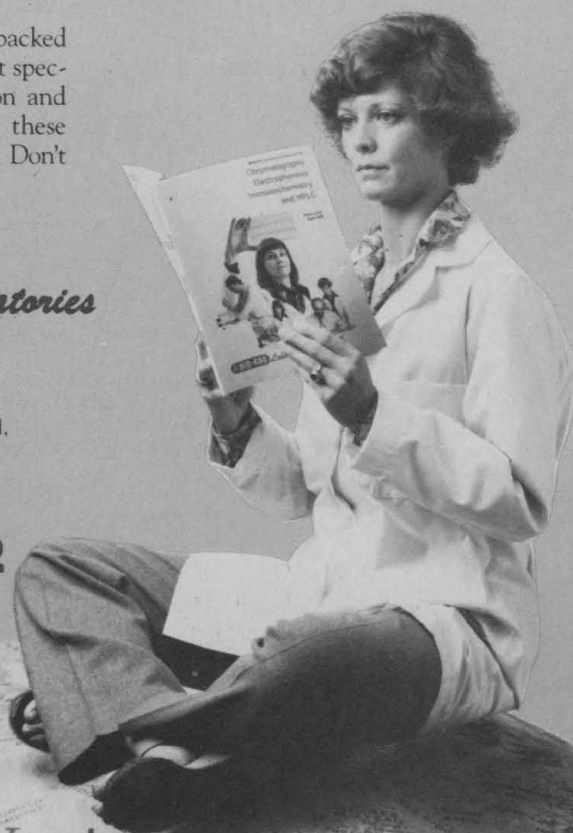
Circle No. 191 on Readers' Service Card

This 140 page catalog is packed with applications data, product specifications, ordering information and abundant tips on how to use these techniques to best advantage. Don't be without it!

 **BIO-RAD** *Laboratories*

BIO-RAD LABORATORIES  
2200 Wright Avenue, Richmond,  
CA 94804, Phone (415) 234-4130  
Also in: Great Britain, Italy, Holland,  
Germany, Austria.

**BIO-RAD  
BACKS YOU UP.**



# SCIENCE

<b>LETTERS</b>	Nuclear Reactor Operators: <i>R. A. Kankus</i> ; "Uninformed Consent": <i>R. B. Marcus, B. Kuklick, S. Bercovitch, J. F. Fries</i> and <i>E. F. Loftus</i> . . . . .	644
<b>EDITORIAL</b>	Synthetic Chemicals in South Africa . . . . .	649
<b>ARTICLES</b>	Solid State Electrodes for High Energy Batteries: <i>D. W. Murphy</i> and <i>P. A. Christian</i> . . . . .	651
	Effects of Energy Conservation in Residential and Commercial Buildings: <i>E. Hirst</i> and <i>B. Hannon</i> . . . . .	656
	Dynamics of Skeletal Pattern Formation in Developing Chick Limb: <i>S. A. Newman</i> and <i>H. L. Frisch</i> . . . . .	662
<b>NEWS AND COMMENT</b>	Califano Exits HEW in Classic Form . . . . .	669
	<i>Briefing</i> : Sex and Science; Grappling over Air Bag; R & D Institute Passed . . . . .	670
	Tracing Burt's Descent to Scientific Fraud . . . . .	673
	Environmental Warfare Treaty . . . . .	674
	More Stress on Applied Science at NSF . . . . .	675
<b>RESEARCH NEWS</b>	The HDL: The Good Cholesterol Carriers? . . . . .	677
<b>BOOK REVIEWS</b>	Women United, Women Divided, <i>reviewed by J. Schneider</i> ; World Industrial Archaeology, <i>E. S. Ferguson</i> ; Proceedings of the Second International Kimberlite Conference, <i>M. Prinz</i> ; The Study of Prosimian Behavior, <i>I. Tattersall</i> ; Books Received . . . . .	680
<b>REPORTS</b>	Disaster, Catastrophe, and Local Persistence of the Sea Palm <i>Postelsia palmaeformis</i> : <i>R. T. Paine</i> . . . . .	685

BOARD OF DIRECTORS					
EDWARD E. DAVID, JR. Retiring President, Chairman		KENNETH E. BOULDING President	FREDERICK MOSTELLER President-Elect	ELOISE E. CLARK MARTIN M. CUMMINGS	RENÉE C. FOX ANNA J. HARRISON
CHAIRMEN AND SECRETARIES OF AAAS SECTIONS					
MATHEMATICS (A) Garrett Birkhoff Ronald Graham		PHYSICS (B) Arthur L. Schawlow Rolf M. Sinclair		CHEMISTRY (C) Fred Basolo William L. Jolly	
PSYCHOLOGY (J) Frances K. Graham Meredith P. Crawford		SOCIAL AND ECONOMIC SCIENCES (K) David L. Sills Gillian Lindt		HISTORY AND PHILOSOPHY OF SCIENCE (L) Melvin Kranzberg Diana L. Hall	
EDUCATION (Q) Fletcher G. Watson James T. Robinson		DENTISTRY (R) Carl J. Witkop, Jr. Harold M. Fullmer		PHARMACEUTICAL SCIENCES (S) Samuel Elkin Robert A. Wiley	
				INFORMATION, COMPUTING, AND COMMUNICATION (T) Mary E. Corning Madeline M. Henderson	
DIVISIONS					
ALASKA DIVISION		PACIFIC DIVISION		SOUTHWESTERN AND ROCKY MOUNTAIN DIVISION	
Daniel B. Hawkins President		T. Neil Davis Executive Secretary		William L. Sims President	
				Alan E. Leviton Secretary-Treasurer	
				Harry J. Shine President	
				M. Michelle Balcomb Executive Officer	
<p><b>SCIENCE</b> 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. 484480) paid at Washington, D.C., and at an additional entry. Now combined with <b>The Scientific Monthly</b>®. Copyright © 1979 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): \$34. Domestic institutional subscription (51 issues): \$70. Foreign postage extra: Canada \$12, other (surface mail) \$15, air-surface via Amsterdam \$40. First class, airmail, school-year, and student rates on request. Single copies \$1.50 (\$2 by mail); back issues \$2.50 (\$3 by mail); classroom rates on request. <b>Change of address:</b> allow 6 weeks, giving old and new addresses and seven-digit account number. <b>Postmaster:</b> Send Form 3579 to <i>Science</i>, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. <i>Science</i> is indexed in the <i>Reader's Guide to Periodical Literature</i> and in several specialized indexes.</p>					

# AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

2-Deoxy-D-Glucose Maps Movement-Specific Nervous Activity in the Second Visual Ganglion of <i>Drosophila</i> : <i>E. Buchner, S. Buchner, R. Hengstenberg</i> . . .	687
Cell-Free Nitrogenase and Hydrogenase from Actinorhizal Root Nodules: <i>D. R. Benson, D. J. Arp, R. H. Burris</i> . . . . .	688
Nonpneumonic, Short-Incubation-Period Legionellosis (Pontiac Fever) in Men Who Cleaned a Steam Turbine Condenser: <i>D. W. Fraser et al.</i> . . . . .	690
Cycloheximide-Dependent Reversion of Human Cells Transformed by MSV and Chemical Carcinogen: <i>H. Y. Cho and J. S. Rhim</i> . . . . .	691
Cerebral Cortical Microfluorometry at Isosbestic Wavelengths for Correction of Vascular Artifact: <i>R. S. Kramer and R. D. Pearlstein</i> . . . . .	693
4-Aminobutyrate:2-Oxoglutarate Aminotransferase in Blood Platelets: <i>H. L. White</i> . . . . .	696
Development of the Rat's Uncrossed Retinotectal Pathway and Its Relation to Plasticity Studies: <i>P. W. Land and R. D. Lund</i> . . . . .	698
Tomatine and Parasitic Wasps: Potential Incompatibility of Plant Antibiosis with Biological Control: <i>B. C. Campbell and S. S. Duffey</i> . . . . .	700
Sexual Difference in Pattern of Hormone Accumulation in the Brain of a Songbird: <i>A. P. Arnold and A. Saltiel</i> . . . . .	702
Synaptic Proteins after Electroconvulsive Stimulation: <i>O. S. Jørgensen and T. G. Bolwig</i> . . . . .	705
Differential Behavioral and Biochemical Effects of Right and Left Hemispheric Cerebral Infarction in the Rat: <i>R. G. Robinson</i> . . . . .	707
Differences in Neural Organization Between Individuals with Inverted and Noninverted Handwriting Postures: <i>M. Moscovitch and L. C. Smith</i> . . . . .	710
Delayed Neurotoxicity of Phenylphosphonothioate Esters: <i>M. B. Abou-Donia</i> . . .	713
Inosine May Be an Endogenous Ligand for Benzodiazepine Receptors on Cultured Spinal Neurons: <i>J. F. MacDonald et al.</i> . . . . .	715
Target Velocity Signals of Visual Tracking in Vermal Purkinje Cells of the Monkey: <i>M. Kase et al.</i> . . . . .	717
Drug Discrimination Training with Progressively Lowered Doses: <i>D. A. Overton</i> . .	720
Superstitious Bar Pressing in Hippocampal and Septal Rats: <i>L. D. Devenport</i> . . .	721
Metabolic Mapping of Functional Activity in the Hypothalamo-Neurohypophyseal System of the Rat: <i>W. J. Schwartz et al.</i> . . . . .	723
Technical Comments: Lead Enhancement of Lithium-Induced Polydipsia: <i>R. P. Wedeen; R. B. Mailman et al.</i> . . . . .	725

MIKE MC CORMACK  
RUSSELL W. PETERSON

JOHN C. SAWHILL  
CHEN NING YANG

WILLIAM T. GOLDEN  
Treasurer

WILLIAM D. CAREY  
Executive Officer

GEOLOGY AND GEOGRAPHY (E)  
Linn Hoover  
Ramon E. Bisque

MEDICAL SCIENCES (N)  
Theodore Cooper  
Leah M. Lowenstein

STATISTICS (U)  
Richard L. Anderson  
Ezra Glaser

BIOLOGICAL SCIENCES (G)  
Donald S. Farner  
Walter Chavin

AGRICULTURE (O)  
J. Lawrence Apple  
Coyt T. Wilson

ATMOSPHERIC AND HYDROSPHERIC  
SCIENCES (W)  
Eugene W. Bierly  
Glenn R. Hilst

ANTHROPOLOGY (H)  
James B. Watson  
Priscilla Reining

INDUSTRIAL SCIENCE (P)  
Herbert I. Fustfeld  
Robert L. Stern

GENERAL (X)  
Ruth B. Pitt  
S. Fred Singer

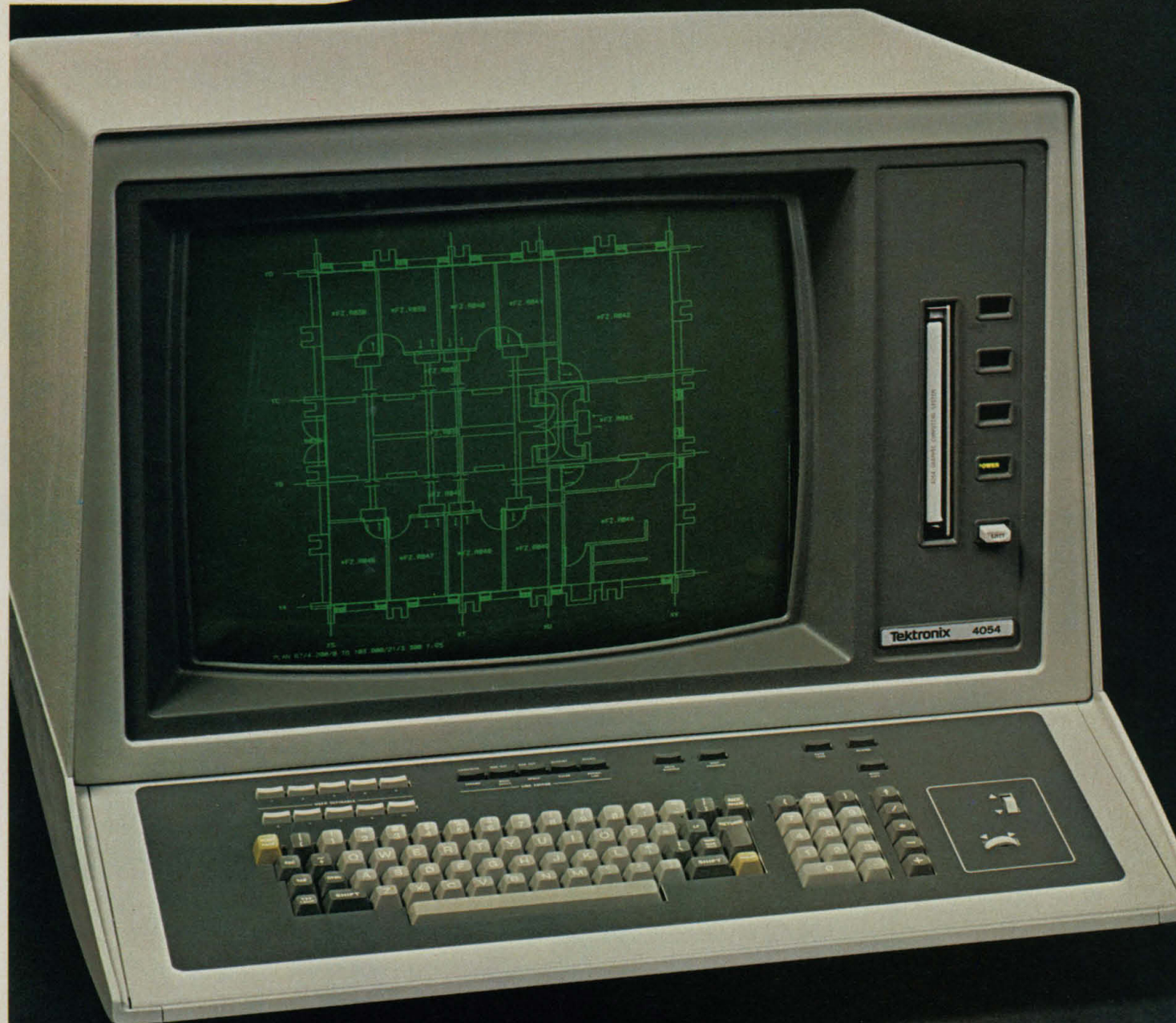
## COVER

Sea palm (*Postelsia palmaeformis*) pictured overgrowing both goosenecked and acorn barnacles and mussels. These competitively brown algae, about 25 to 35 centimeters tall, inhabit sites characterized by extreme wave shock (Tatoosh Island, Washington). See page 685. [A. R. Palmer, University of Washington, Seattle]

The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.



From the graphics leader

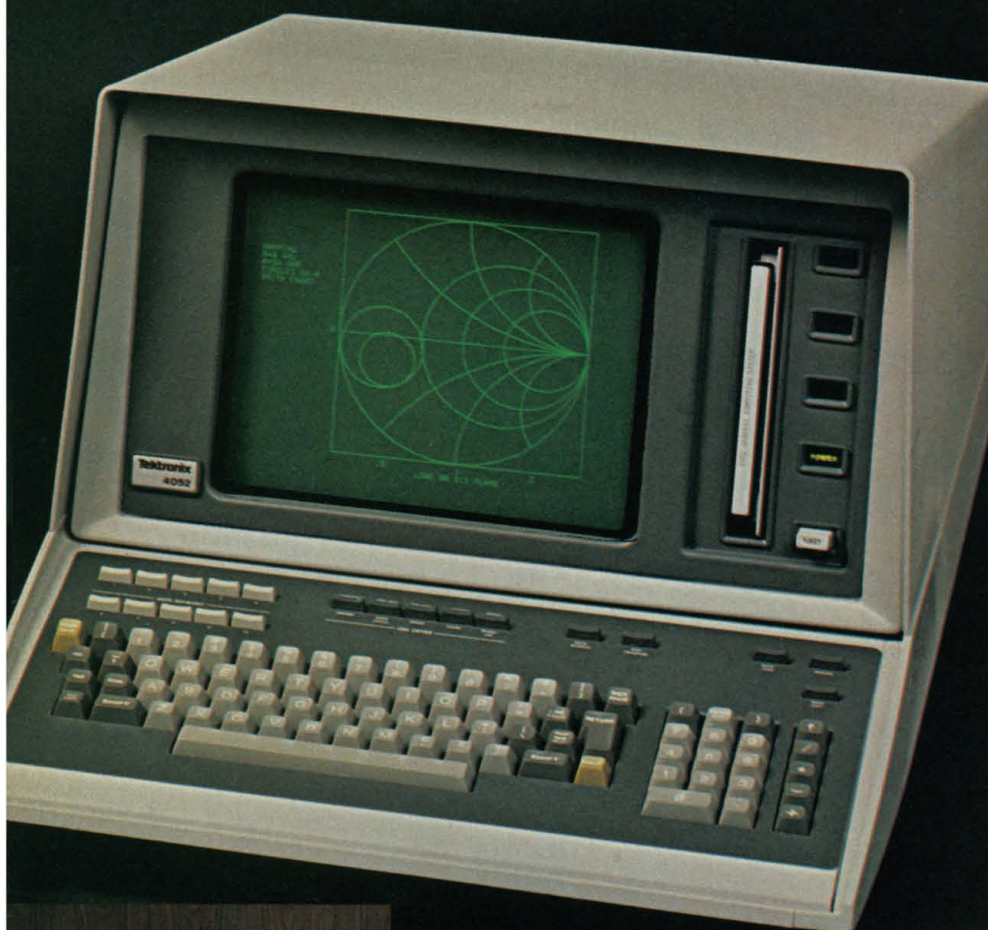


4054 display courtesy Applied Research of Cambridge, Ltd. Copyright © 1979, Tektronix, Inc. All rights reserved. OEM information available.

**Two new desktop  
computers. By Tektronix.**

**Faster processing.  
Finer detail. Both as easy  
as they look.**





computational speed. Including built-in binary loader and matrix functions, it brings to the lab researcher, statistician and business analyst new power and memory capacity.

The new 4054 is the first desktop computer with a 19-inch display. Information density is 16 times greater than our own 4051 desktop computer. It brings personal processing convenience to the engineer. The designer. To anyone who needs graphics precision down to the last detail.

Best of all, they're built to look easy. Learn easily. To make sense. Graphically-enhanced BASIC; contoured; typewriter-like keyboard; 100% software compatibility among all computers in the series, plus our full complement of peripherals—all combine with the inherent simplicity of graphics to make your problem-solving personal, powerful, and easy.

Call our toll-free answering service at 1-800-547-1512 (in Oregon, call 644-9051 collect). Or write:

**Tektronix, Inc.**  
Information Display Division  
P.O. Box 500  
Beaverton, OR 97077  
(503) 682-3411

**Tektronix International, Inc.**  
European Marketing Centre  
Post Box 827  
1180 AV Amstelveen  
The Netherlands  
Tel. 020-471146

**Tektronix®**  
COMMITTED TO EXCELLENCE

Circle No. 240 on Readers' Service Card

**F**rom the innovator  
of desktop graphics:  
The easiest  
computers that ever  
gave a graphic answer.

One built for size. Both built for speed. Both featuring unexcelled user convenience from any point of view.

The new 4052 has speed on its mind. It is designed around an advanced microprocessor that provides vastly increased

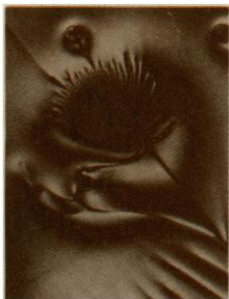






Photomicrograph by Michael Siegel





The ability to precisely and faithfully record specimens on film has always been the ultimate test of microscope optics. Shortcomings that would be insignificant in less exacting tasks are glaring in a photomicrograph.

Now, with a single stunning innovation, Nikon has produced an unprecedented advance in microscope technology. Called CF optics, it's a development so revolutionary that it represents far more than a

refinement. It stands as nothing less than an entirely new standard of light microscope performance. A standard against which all others will be measured.

To achieve this dramatic breakthrough, Nikon engineers combined a new, extra-low dispersion glass with an ingenious concept in optical design to virtually eliminate chromatic aberration. The Nikon CF system delivers unparalleled resolution, color fidelity, flatness of field and image

brightness. In fact, CF optics bring to Nikon resolving power closely approaching theoretical limits.

The most exacting requirements of photomicrography demand the ultimate. Nikon. The difference between seeing and not seeing. Knowing and not knowing.

For further information on the entire line of Nikon instruments for photomicrography, contact: Nikon Incorporated, Instrument Division, Ehrenreich Photo-Optical Industries Inc. • 623 Stewart Avenue, Garden City, NY 11530. (516) 222-0200.

**Look to Nikon**

ニコンとご用命下さい

Blicken Sie auf Nikon

Circle No. 282 on Readers' Service Card

# FOR PHOTOMICROGRAPHY, LOOK TO NIKON.

## I HFM/AFM/PFM MICROFLEXES

— Choose the camera system with the degree of automation you require. From the HFM's totally computerized exposure selection range of 1/60th sec. to 30 min. through the PFM with its manual control of speeds from 1/250th sec. to 1 sec. plus B and T.

## II SMZ-10 MICROSCOPE WITH AFM MICROFLEX AND MK II LIGHT SOURCE

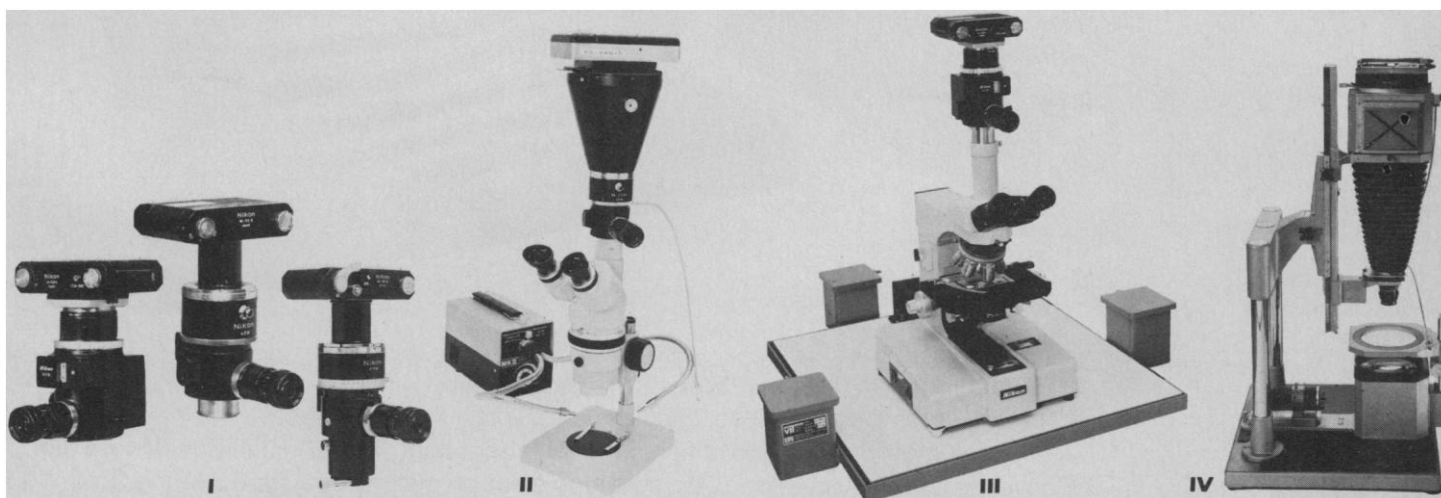
— This system combines high resolution with the ability to photograph actual stereo pairs for instant prints. The MK II fiber optic light source provides intense spot illumination without heat. The self-supporting light pipes require no clamps or holders to maintain position.

## III BIOPHOT MICROSCOPE WITH HFM AND VIT

— Placing your Nikon microscope and camera system on a VIT tabletop effectively isolates it from 99% of high frequency and 90% of low frequency shock and vibration. The system is especially useful in urban and industrial environments.

## IV MULTIPHOT UNIVERSAL PHOTOGRAPHIC SYSTEM

— For high resolution photomicrographs, its magnification range of 1/3X to 40X is ideal. Designed with high rigidity and excellent optics for sharp images, it accommodates most any film format. Offers resolution and contrast superior to conventional compound and stereo microscopes at ultra low magnifications.





# Technical for impatient



- a. Torque test, axle bolt. Type 667 Coaterless film.
- b. CRT graphic display. Type 084 film.
- c. Interferometric evaluation of flat mirror with laser light. Type 57 High Speed 4 x 5 film.
- d. Converter circuit inspection 700x, scanning electron microscope. Type 52 Fine Grain 4 x 5 film.
- e. Memory circuit, 100x. Type 665 Positive / Negative film.



# photography people.

If you need photographs of your work, why sit around waiting for them? With Polaroid instant photographic equipment you get immediate results.

Our wide range of equipment lets you record everything from microbes to metal stress tests. With Polaroid self-developing films you can have professional quality results in color in 1 minute, or in black and white (with or without a usable negative) in seconds. And our equipment is simple to use. So you can take the photographs you need without needing to know a lot about photography.

The MP-4 Multipurpose camera (1) is a versatile, self-contained photo studio anyone can operate. It uses 14 different Polaroid instant films to keep you out of the darkroom. And it copies, delivers close-ups, reductions, macro-photographs and photo-micrographs, to bring your answers to light.

Our CU-5 Close-up camera (2) is a lightweight, hand-held system you can take almost anywhere and get instant photos from  $\frac{1}{4}$  to 3 times life size. Exposure is easy to set,

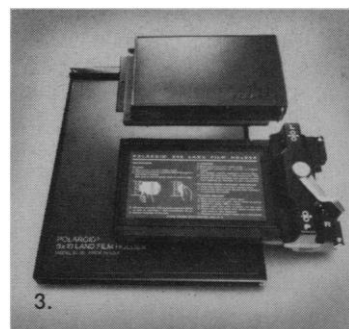
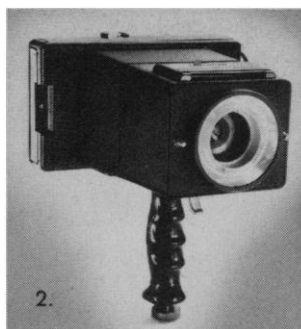
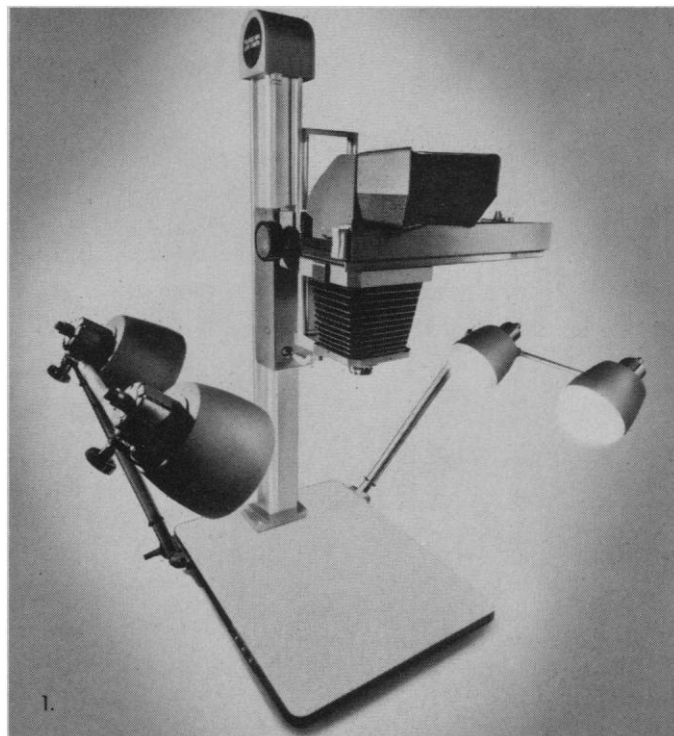
lighting is built in and framing is automatic. So all you have to think about is the picture. You can even use the CU-5 to capture a transient image on a cathode ray tube.

Many cameras and instruments can be adapted quickly and easily for instant photography with Polaroid film holders (3). They come in 3 models to handle 3 different sizes of Polaroid Land film ( $3\frac{1}{4} \times 4\frac{1}{4}$ ,  $4 \times 5$ , and  $8 \times 10$  in.), so you can get instant results in almost any format.

Many other manufacturers of cameras and instruments also supply Polaroid Land camera backs that adapt their equipment to instant photography. These backs use 9 different convenient Polaroid pack films, so you can see your project in a new light.

To find out how you can get instant results, mail the coupon below. Or if you're a very impatient person, call us toll-free from the continental U.S. at 800-225-1618 (from Massachusetts, call collect 617-547-5177).

And stop tapping your foot while you wait for your photos to come back from the lab.



## Polaroid

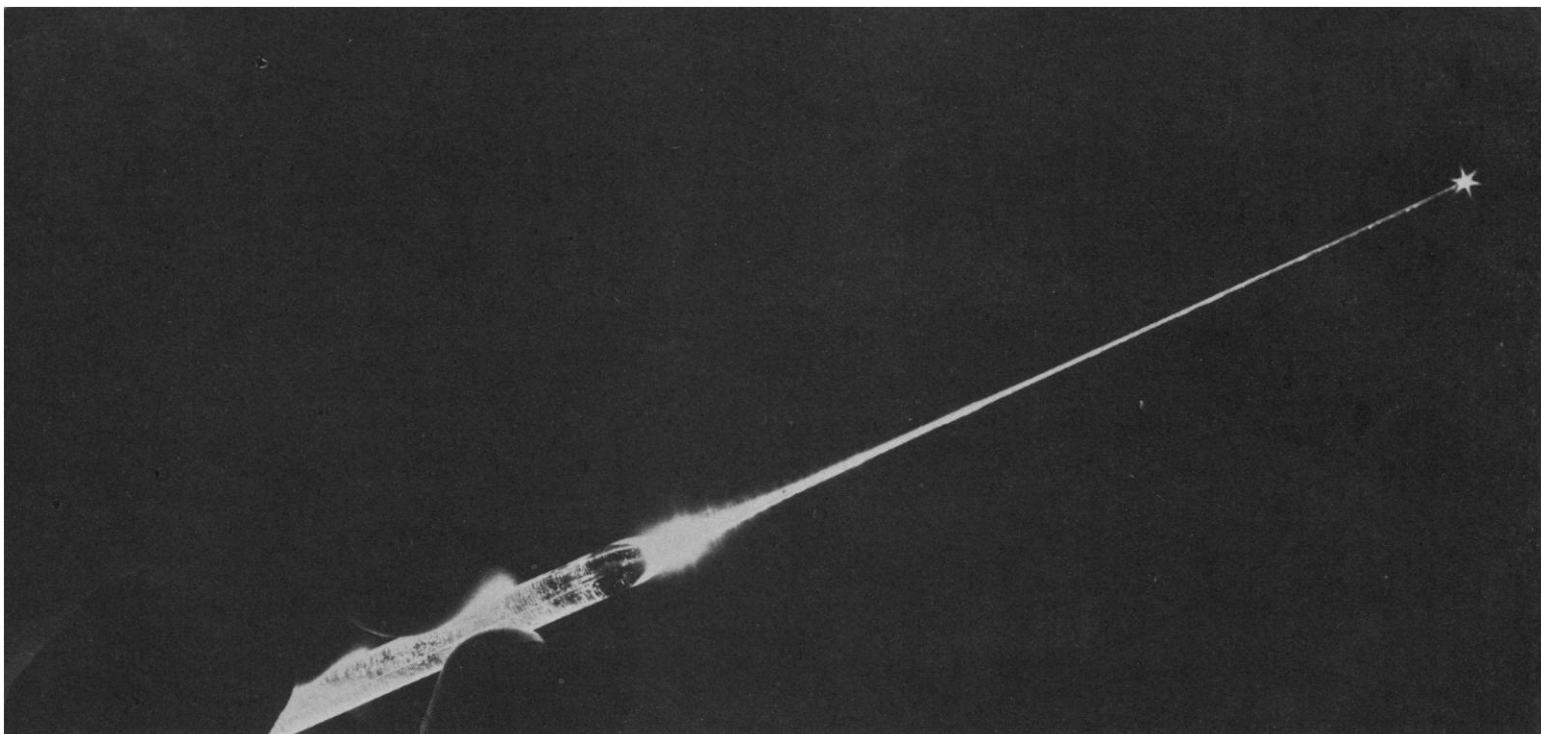
Instant Laboratory Pictures

Polaroid Corporation  
Industrial Marketing, Dept. A435  
575 Technology Square  
Cambridge, Mass. 02139

I'm impatient. Please send me more information on how I can use Polaroid instant photography in my work.

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_  
Current camera or instrument \_\_\_\_\_  
Application or need \_\_\_\_\_





# Why this one-of-a-kind invention didn't end up as the only one of its kind.

Every new invention needs another new invention—the one that can mass-produce it at an affordable cost.

For example, Bell Labs invented a process for making the glass rods from which hair-thin fibers used in lightwave communications can be drawn. The fibers have far greater capacity than conventional copper wires, so they'll help keep costs down. In fact, they've been carrying voice, data, and video signals under city streets for about two years in a Bell System demonstration.

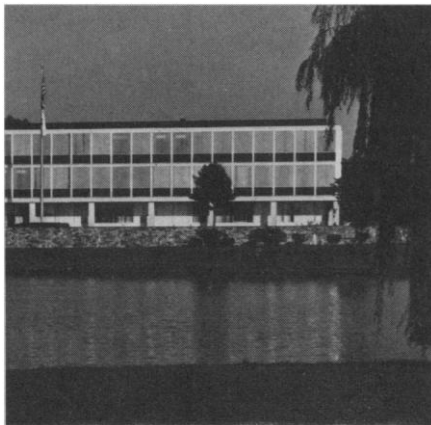
But standard lightwave systems will require *miles* of the fiber, produced at low cost and to specifications nothing short of microscopic.

That's where Western Electric's Engineering Research Center comes in.

## A Unique Center

The Center is devoted exclusively to manufacturing research.

Here, a highly trained team of scientists and engineers probe fundamental questions about materials and processes. They provide Western Electric factories with pre-tested,



proven ways to manufacture products based on the latest technology coming out of the laboratory.

For example, while Bell Labs scientists were inventing new glass fibers, Western Electric engineers and scientists were tackling the manufacturing problems involved.

The fibers had to be drawn from molten glass at high speeds, with less than a 1% deviation in diameter.

But how do you control a "thread" of glass being spun at rates up to 15 feet per second?

Scientists and engineers at the Center discovered that laser light beamed onto the fiber cast a characteristic pattern.

By correlating the pattern to the fiber's diameter, they were able to build a monitoring system into the fiber drawing machinery. It measures the fiber 1000 times per second, automatically adjusting production to keep the diameter constant.

The system works so well that in all the miles of fiber produced by Western Electric, the diameter varies by no more than 30-millionths of an inch.

## The Key to the Future

In the Bell System, technology is the key to keeping costs down. It is the key to constantly improving your phone service.

And Western Electric's Engineering Research Center is an essential link between the ideas of the laboratory and the realities of the factory.

So your Bell Telephone Company can make the best one-of-a-kind inventions a part of your phone service.

*Keeping your communications system the best in the world.*



# Western Electric



# The Beckman gamma choice. Big enough to let you be choosy.



Beckman now offers the research and clinical laboratory a complete choice of gamma-counting instruments. Check the features below to find the one instrument that can most effectively satisfy your needs.

The low cost Gamma 4000 is a high performance, bench-top unit featuring ease of operation, 200 or 400 sample capacity, preset and variable windows, and a choice of print-out devices. The optional DP-5000 computer/printer provides on-line data reduction capability—for Radio-Immunoassay final answer calculations.

The Gamma 7000 is micro-processor controlled and offers high

performance features with push-button simplicity. Permanently stored counting programs eliminate all knobs, manual controls and switches to make operation fast, easy and more reliable. Simply select the desired program, load samples and depress the AUTO pushbutton—a completely simple and thorough approach to counting.

The Gamma 8000 takes micro-processor-control one step further and allows the user to design special counting programs, while maintaining the simplicity of operation unique to Beckman Instruments.

Finally, there's the Gamma 9000 with the ultimate in data-handling

capability. Built right into the 9000 is a complete computer that both controls the operation of the instrument and takes your data through to final answer.

Of course, if you're really going to be choosy about your next gamma instrument, you'll need complete technical information. Why not get it now?

Contact Scientific Instruments Division, Beckman Instruments, Inc., P.O. Box C-19600, Irvine, CA 92713.

**Innovation you can count on**

Circle No. 301 on Readers' Service Card

**BECKMAN®**



# VAX Program Capacity. Ask any user.

**"VAX offered us almost three times the address space of our 370/168."**

*Bill Miller, Senior Systems Analyst  
Chevron Geophysical Co., Houston, Texas*



Chevron Geophysical is heavily engaged in seismic data processing involving matrix operations on large arrays.

As Senior Analyst Bill Miller states the problem: "Our IBM systems, running on TSS, give 24 bits of true address space — for a maximum program size of 16 megabytes. But only 10 to 12 megabytes of this can be used by the programmer — and our application had grown to the point that TSS was simply cramping us.

"With the VAX-11/780, we know we can have application programs that use a full 32 megabytes as we're configured now — and it could be more if we wanted."

But Chevron didn't buy their VAX without first benchmarking it against the far more expensive 168.

Miller comments: "We developed a number of benchmarks to test specific areas of performance. On the average, the VAX CPU appears

to be about a third as fast as the 168, which is really quite impressive. And it's very possible that for certain applications, we may see a negligible loss of throughput over the 168, thanks to VAX's unique page clustering scheme."

And as far as system performance to date, Miller reports: "The VAX/VMS operating system has been remarkably reliable. The people at Digital have done a phenomenal job."

**"VAX's true 32-bit addressing puts its potential capacity so far out, we don't have to worry about it."**

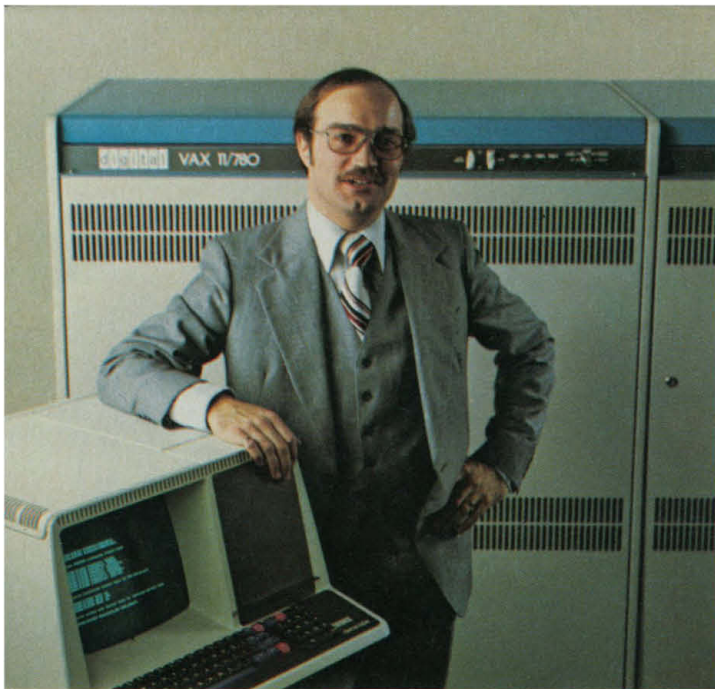
*Dr. Edwin Catmull, Director,  
Computer Graphics Lab  
New York Institute of Technology,  
Old Westbury, New York*

The Computer Graphics Lab at New York Institute of Technology is a leading research and production facility for computer animated commercial and educational films.

In Dr. Catmull's words, here's what brought NYIT to the VAX-11/780: "While spending years developing our capabilities with mini-computers, we







## **"With a 22,000-point data base, we really needed VAX's huge memory capacity."**

*Peter Ackermans, Manager of Computer Systems Engineering  
CAE, St. Laurent, Quebec, Canada*

CAE Electronics Ltd., currently has thirteen VAX-11/780 systems under development for both flight simulation and supervisory power control.

Here again, VAX capacity was key. Systems Manager Peter Ackermans told us: "Our SCADA systems for the power market need to handle a 22,000-point data base. VAX's large memory capacity and the VAX/VMS virtual memory operating system made it a very attractive machine."

But speed was also important. "In flight simulators," Ackermans continues, "top FORTRAN performance is essential, and on that score, VAX measures up well. Our FORTRAN programmers have also been impressed with the machine's debug facility and file handling capabilities."

Digital's VAX-11/780, with its true 32-bit address space, has set a new standard for program capacity. This means that you can run large programs easily on VAX, with a potential for growth that's unmatched in the industry.

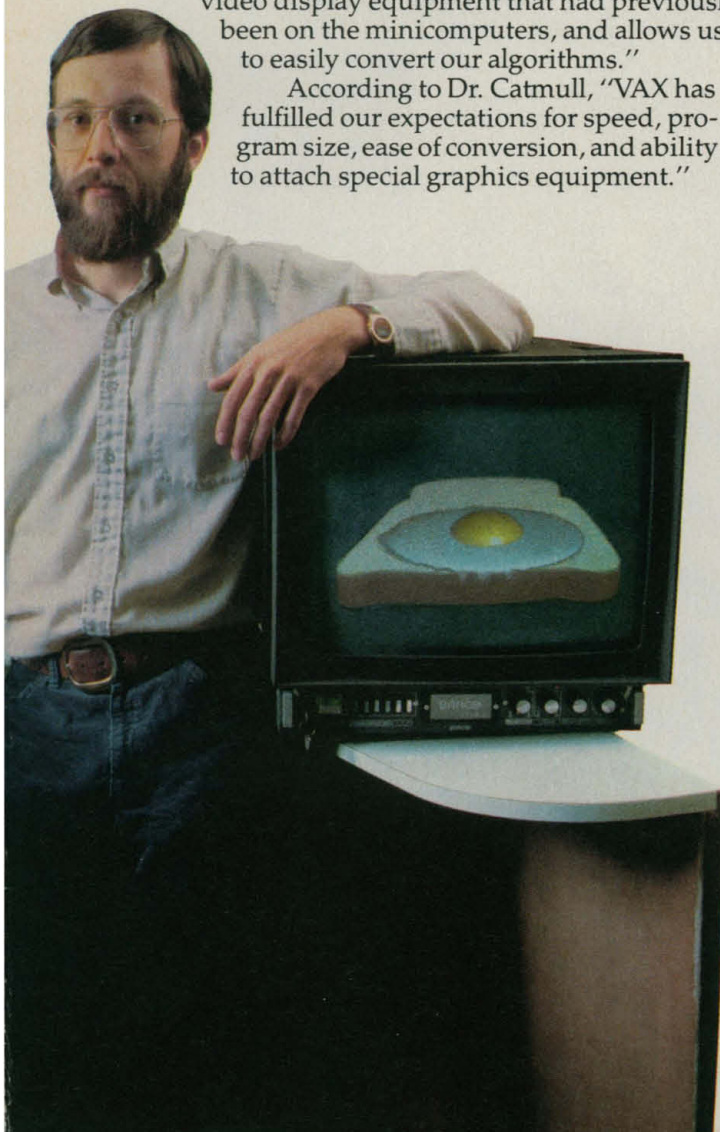
But rather than have us tell you about it, send for our new brochure.

And listen to our customers.

continually ran into the problem of small address space. Our work demands the large address space we can get with a 32-bit machine. We were dealing with extremely large, randomly accessed data bases, and memory mapping is not the answer."

Dr. Catmull continues, "The VAX UNIBUS lets us easily hook up a wide range of special video display equipment that had previously been on the minicomputers, and allows us to easily convert our algorithms."

According to Dr. Catmull, "VAX has fulfilled our expectations for speed, program size, ease of conversion, and ability to attach special graphics equipment."



- ☐ Please send me the new "VAX—Ask Any User" brochure and detailed Technical Summary.
- ☐ Please contact me.

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Phone \_\_\_\_\_

My application is: ☐ Education ☐ Medical ☐ Laboratory  
☐ Engineering ☐ Government ☐ Resale ☐ Other.

Send to: Digital Equipment Corporation,  
Communication Services, 146 Main St., NR-2/2,  
Maynard, MA 01754. Tel. 617-481-9511, ext. 6885. S-8-17-9

Circle No. 207 on Readers' Service Card

**digital**



# "Engineering to business to math: Every term my students invent new uses for 4006-1 graphics."

**Dr. R.L. Phillips**  
**University of Michigan**

**Computer graphics is usually used as a tool for teaching specific subjects. But Dr. Phillips unleashes a world of subject matter as a tool for teaching graphics.** One project in his course on graphics asks students to develop their own graphics applications. The results continually demonstrate graphics' versatility as a personal learning device.

**"I never cease to be amazed," Dr. Phillips says.** His students have

developed programs to produce flow charts. To design aircraft. Even to compose music.

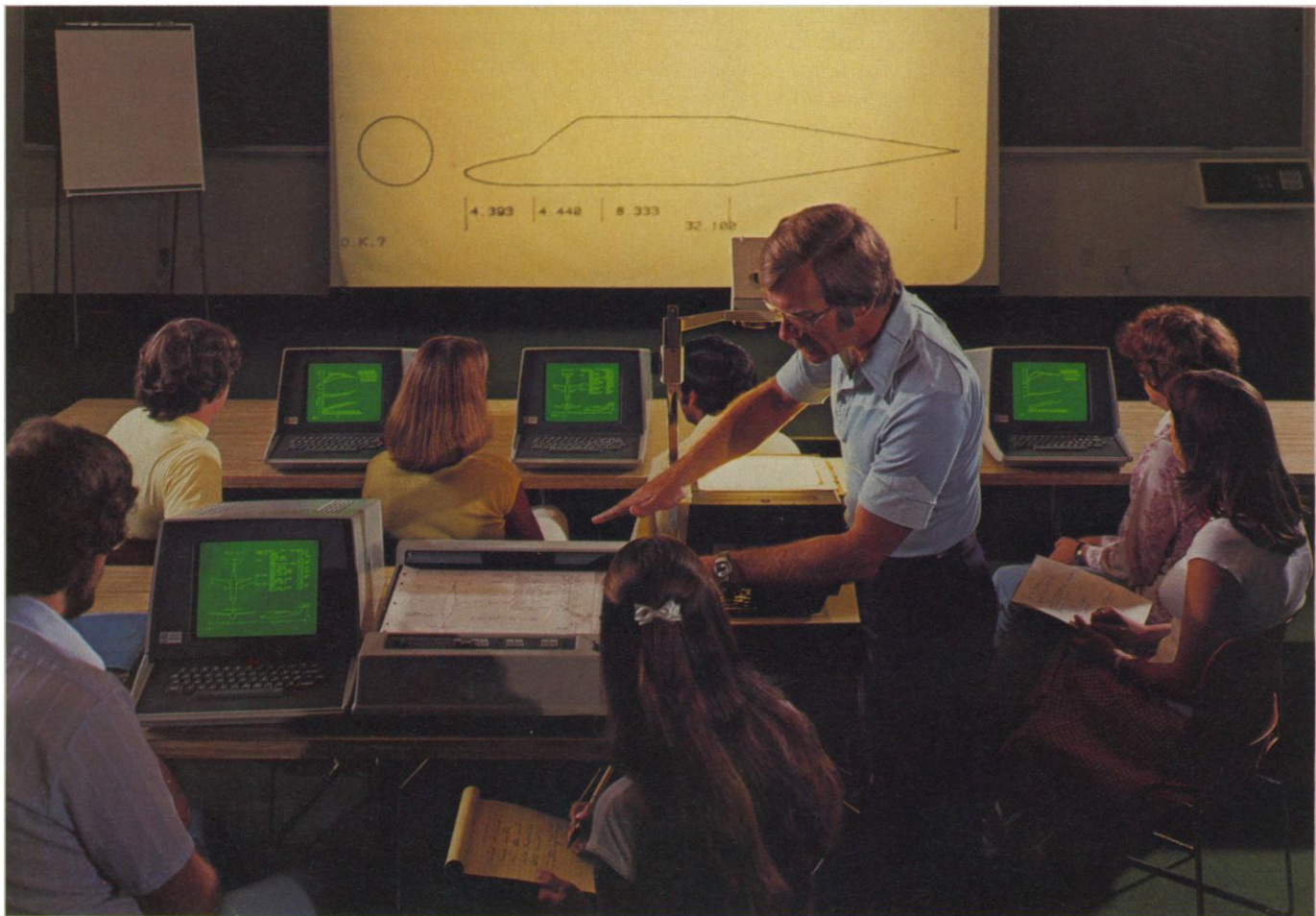
**The equipment, of course, is from Tektronix.** Terminals like our 4006-1 have been acclaimed as a boon to personalized instruction in teaching computer graphic methods and applications.

**Students and teachers are discovering new graphic applications everyday. And there's no end in sight.** For a video

tape on Computer Graphics in Learning, application or product literature, please write: Institutional Market Manager

**Tektronix, Inc.**  
Information Display Group  
P.O. Box 500  
Beaverton, Oregon 97077  
**Tektronix International Inc.**  
European Marketing Centre  
Postbox 827  
1180 AV Amstelveen  
The Netherlands  
Tel: 020-471146

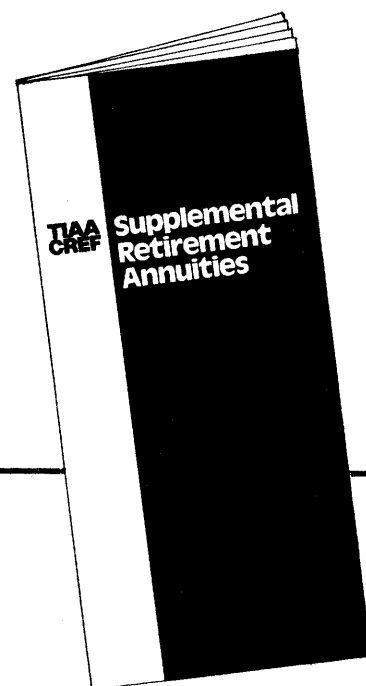
**Tektronix**  
COMMITTED TO EXCELLENCE



Copyright © 1978, Tektronix, Inc. All rights reserved.



# TIAA-CREF Supplemental Retirement Annuities



## for tax-deferred annuity programs

Supplemental Retirement Annuities (SRA's) are new forms of TIAA and CREF contracts designed expressly for use by persons who want to set aside tax-deferred retirement funds over and above amounts being accumulated under their institution's basic retirement plan. They are available for employees of colleges, universities, private schools and certain other nonprofit educational organizations with tax-deferred annuity (salary-or-annuity option) programs. Through a properly drawn agreement with their institution, staff members may divert part of their compensation before taxes to the purchase of these new contracts.

**And SRA's are cashable at any time.** This means that if the money accumulated by salary reduction is needed before retirement, the SRA contracts can be surrendered for their cash value. Benefits, whether payable in cash or as income, are taxable as ordinary income when received.

For more information and answers to questions send for your copy of the booklet on Supplemental Retirement Annuities.

**S**end me a booklet describing  
TIAA-CREF Supplemental Retirement Annuities.



Name \_\_\_\_\_ Date of Birth \_\_\_\_\_

Address \_\_\_\_\_  
Street

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Nonprofit  
Employer \_\_\_\_\_

Teachers Insurance and Annuity Association  
730 Third Avenue, New York, New York 10017

wi

# Fingertip phase.

## Finest optics, easiest phase

The Zeiss Clinical Standard Microscope literally puts phase at your fingertips. You just swing in the phase ring. That's all there is to it. Once you've used Zeiss phase, you'll never want to use any other method. Or fuss with any other phase microscope, no matter how simple it's claimed to be. Zeiss beats them all because Zeiss optics are the best.

## Economical phase, screening darkfield

With no extra cost, you get screening darkfield. Switch from 100X screening darkfield to 400X phase with fingertip ease. No centering. No aligning. Zeiss Clinical Standards are competitively priced to start with, and are so designed that phase can be added at minimal expense.

## Nationwide service.

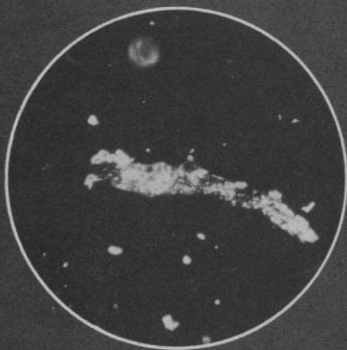
The great name in optics

# ZEISS

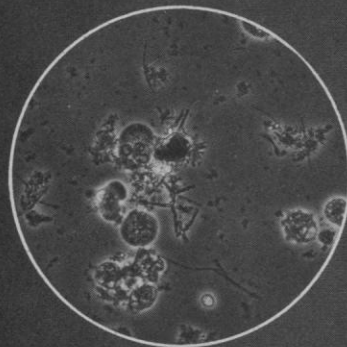
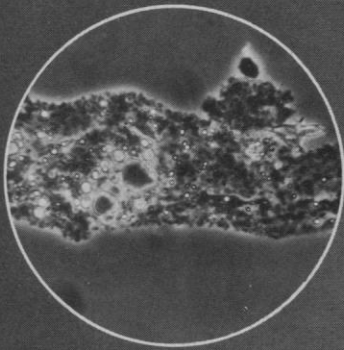
West Germany

**Carl Zeiss, Inc., 444 5th Avenue, New York, N.Y. 10018 (212) 730-4400.** Branches: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D.C. In Canada: 45 Valleybrook Drive, Don Mills, Ontario, M3B 2S6. Or call (416) 449-4660.

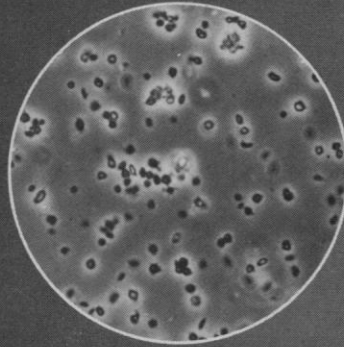
Fatty cast—  
screening darkfield\*



Same fatty cast—  
high dry phase\*

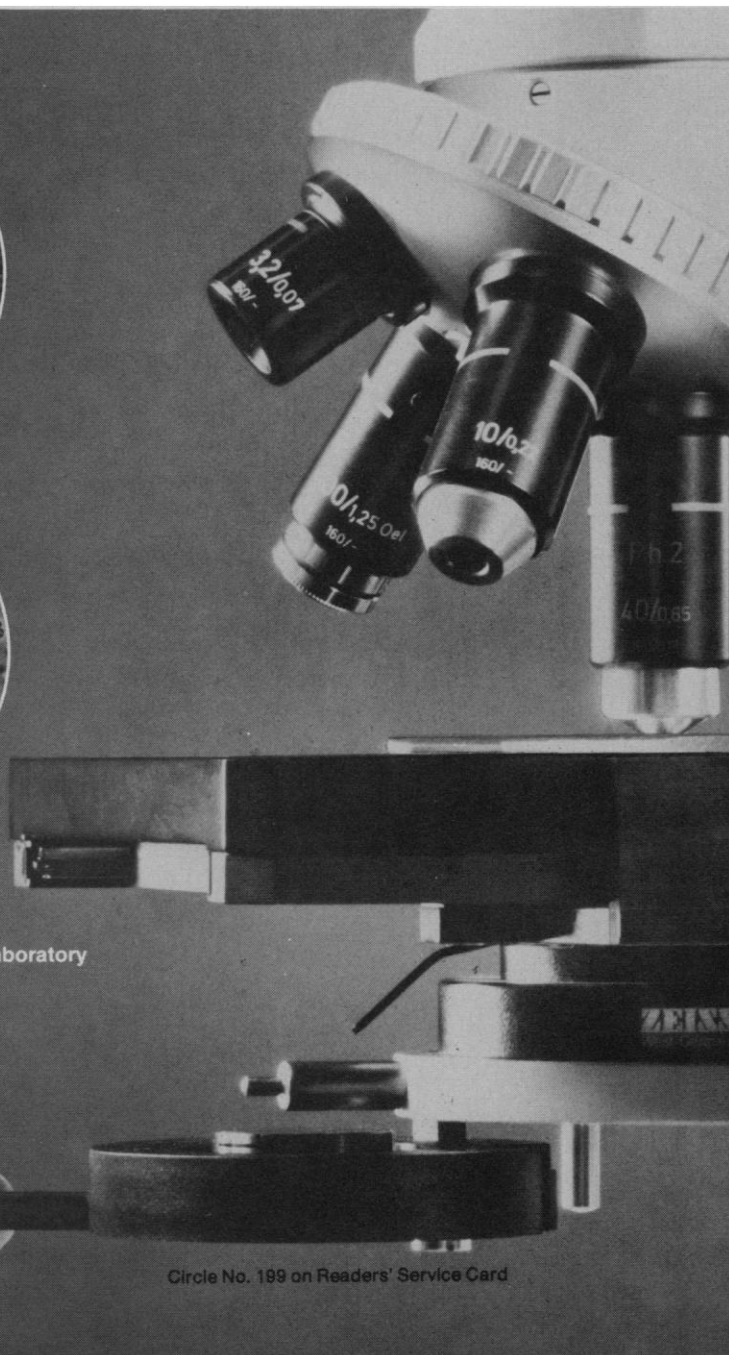


Vaginal flora, mycoses—  
high dry phase



Platelets—high dry phase

\*Photomicrographs courtesy of Karen M. Ringsrud, Department of Laboratory Medicine and Pathology, University of Minnesota



Circle No. 199 on Readers' Service Card



# IT'S EASIER TO CONCENTRATE WITH S&S COLLODION BAGS...

the only system to  
use for simultane-  
ous concentration  
and dialysis. The

S&S system of collodion bags and apparatus is the simplest and fastest way to concentrate proteins and nucleic acids. The bags are available in MW retentions of 10,000, 25,000 and 75,000, and offer fast, convenient concentration and easy collection of the fraction. Recovery is greater than with other systems.

The collodion bag system can reduce protein solutions to near-zero volumes. For instance, the UH 100/25 bags with a 25,000 MW cutoff are ideal for use in concentration of antibodies, enzymes, blood fractions, and concentration of urine, synovial and cerebral spinal fluids.

Contact your laboratory supply dealer or write for Bulletin M-82. Schleicher & Schuell, Inc., Keene, NH 03431. (603) 352-3810. With S&S, it's in the bag.

Schleicher & Schuell



Circle No. 206 on Readers' Service Card

## FREE Catalog

New 4-way relief from problems with minicomputer supplies and accessories.

### 1. One-stop shopping.

Inmac (formerly known as Minicomputer Accessories Corporation) has a catalog of over 800 products. Everything from racks and line-printer paper to connectors and cables. Each designed to help keep your minicomputer or word processing system up and running.

### 2. Hassle-free ordering.

Inmac lets you order by mail or phone. So keep our Summer '79 catalog close. It makes those once-tough tasks like ordering magnetic media easy, fast and foolproof.

### 3. Fast shipment of just the quantity you need.

Inmac ships your order within 36 hours from centers in California and New Jersey. In a bind? Call us for many special services that insure you get your order to your installation within 24 hours. Call now and give us a chance.

### 4. Field-proven quality means precision performance.

Inmac guarantees every product in these 70 pages for at least 45 days. And even some for up to ten years.



**Inmac**  
International Minicomputer Accessories Corporation

Send for your **FREE**  
Inmac catalog or call  
(408) 727-1970 today!

2465 Augustine Drive, P.O. Box 4780, Santa Clara, CA 95051  
© 1979 International Minicomputer Accessories Corporation

Circle No. 202 on Readers' Service Card

## NICK TRANSLATION SYSTEM

The world's first. Packaged complete.



Naturally it is more convenient than assembling the components yourself. But even more important is its reliability.

For example, the *E. coli* DNA Polymerase I is cloned in our laboratories to ensure extremely high reproducibility. The dCTP, [ $\alpha$ -<sup>32</sup>P]- is tested for nick translation by our Biological Testing Laboratory. (Typical incorporation is 40%, and we guarantee  $1 \times 10^8$  dpm/ $\mu$ g DNA.) The supercoil PBR322 Plasmid DNA control we use to test each lot of systems is included so you can check yours. Finally, the DNase I, dNTP mixture, stop-buffer, and sterile deionized water are optimized for compatibility and stability. Approximately twenty assays can be run. A bulletin describing this exclusive system is yours for the asking.



**New England Nuclear**

549 Albany Street, Boston, Mass. 02118, Toll-free: 800-225-1572  
(In Massachusetts and International: 617-482-9595)

**NEN Chemicals GmbH:** D-6072 Dreieich, W. Germany, Postfach 401240, Telephone (06103) 85034, Telex 4-17993 NEN D.  
**NEN Canada Ltd.,** 2453 46th Avenue, Lachine, Que H8T 3C9, Telephone 514-636-4971, Telex 05-821808

Caution: Not for use in humans or clinical diagnosis.

# Ohaus Brainweigh 300

## Never before, for so little, could you get so much.

The Ohaus Brainweigh 300 costs only \$1,195 and gives you a capacity of 300g with a readability of 0.01g. (If you want to find out how much that price is going to save you, just check what our competitors are charging for balances with similar capabilities.)

And we didn't stop with just economy. We went on to design in features that would be costly "extras" on any other balance on the market—if you could even get them.

### Like extended visibility



Stand up; sit down; go to the back of the room. The display on the Ohaus 300 is still easy to read. That's

because the no-glare window with the big, easy-to-read digits is deliberately angled for maximum visibility wherever you are. And that can save a lot of headaches whether you're in a lab, or on the line or in a classroom.

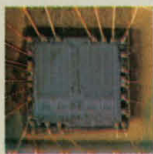
### It tells you when it's ready—and when you've goofed



No more guessing whether the balance has settled down; no more annoying digit flutter. When the "g" appears beside the digits—in 3 seconds or less—it's your guarantee that the reading is stable.

And if the pan is overloaded or dislodged, you'll get an error sign in the window.

### The 300 is a new generation balance



This new, low-profile balance is only a little larger than an ordinary desk phone. But packed inside is enough advanced technology to make the Ohaus 300 a generation ahead of any other balance on the market. Its state-of-the-art electronic components are almost entirely plug-in for easy service. And there are fewer of them—for better reliability and more dependable performance.

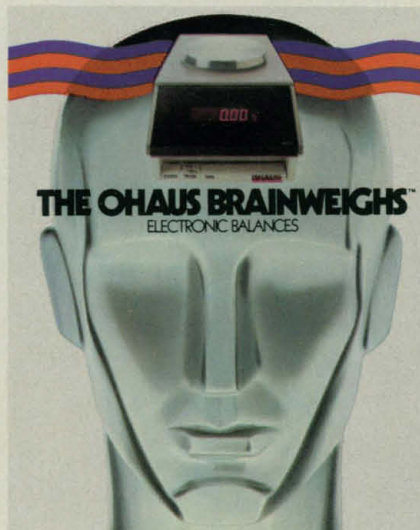
### Want a BCD interface now—or later?



You don't have to worry about it. Unlike other electronic bal-



ances, every Ohaus Brainweigh comes equipped to handle a BCD option. You can add a BCD interface right away—or whenever you come to need it.



### Parts and service are as near as your dealer

The Ohaus 300 is made right here in the U.S. And although its built-to-take-it die-cast case and solid state components put maintenance at a minimum, when the balance finally needs a little attention, it's nice to know your local dealer can do the job.



### Get all the facts

If you'd like to see the rest of the reasons why the Ohaus Brainweigh 300 outclasses the competition, and the many ways it can make your operation faster, easier and more accurate, just return the coupon.

**THE OHAUS  
BRAINWEIGHS™**  
The weigh of the future.

©1979 Ohaus Scale Corporation

**OHAUS**

©Ohaus Scale Corporation, Dept. 14-089  
29 Hanover Road, Florham Park, N.J. 07932  
(201) 377-9000

- ☐ Yes, show me the weigh of the future. Send me the full-color catalog on the Ohaus Brainweighs.  
☐ I'm ready to see a demonstration. Please have a dealer sales rep call me.

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Organization \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_  
Phone Number \_\_\_\_\_

Circle No. 167 on Readers' Service Card



# If it isn't a Napco® you may be reading the temperature in the water jacket ...not the chamber.

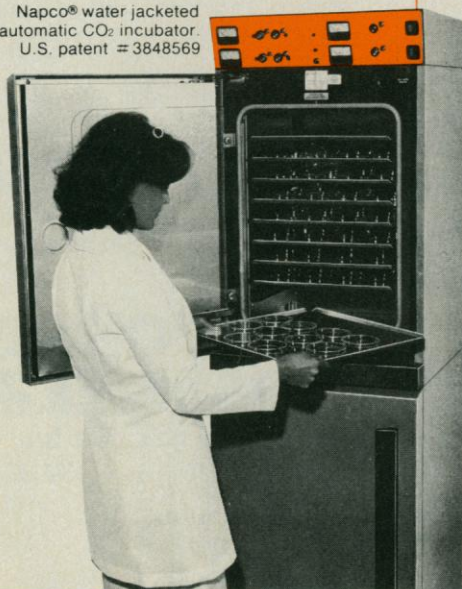
The Napco 7000 series are the only water jacketed automatic CO<sub>2</sub> incubator that actually tells you the temperature of the chamber, where your important experiment is taking place.

All other water jacketed automatic CO<sub>2</sub> incubators read the *temperature of the water*, not the chamber environment. If your

research is temperature sensitive, reading the exact temperature of the chamber is critical.

For accuracy and reliability, insist on the Napco 7000 models. They are the most advanced incubators on the market. Available in single or space saving vertical models. There's much more. Write for brochure.

Napco® water jacketed  
automatic CO<sub>2</sub> incubator.  
U.S. patent # 3848569



## National Appliance Company

A Heinicke Company  
3000 Taft Street  
Hollywood, FL 33021  
800-327-9783 or  
(305) 987-6101

Available at the following dealers:  
Curtin-Matheson  
Fisher Scientific Co.  
Preiser  
Sargent-Welch  
S.G.A. Scientific  
Scientific Products  
Arthur H. Thomas Co.  
VWR  
In Canada:  
Canlab  
Fisher Scientific Co. Ltd.  
Sargent-Welch of Canada Ltd.

If you should ever have an equipment breakdown...

**a Heinicke/ Napco Minute Man will be  
on his way to you in 48 hours.**

You'll seldom need the Minute Man service, because Heinicke and Napco instruments are built to work. But if you do, just dial toll-free 800-327-9783.

novel theory concerning the predictability of heart attack. We welcome the opportunity to recapitulate our arguments.

We strongly uphold the right of individuals to determine for themselves what will be done to their minds and bodies. The basic right to self-determination, however, is threatened by two forces represented in the current "rituals" offered in the name of "informed consent." An informed consent ritual is an attempt to defend the underlying "right"; it is not in itself, either legally or ethically, a "right." It is justified *only* to the extent that it actually promotes self-determination. We very deliberately chose the term "ritual" to distinguish certain practices from the underlying "right" to self-determination. The ethical question with such "rituals" is whether or not they are the best possible ones to ensure that the "right" is protected.

The threats are these. First, institutional lawyers dictate the form of recommended consent forms, so that the forms become releases designed to protect the institution, not information designed to inform the individual. One has only to read a few such forms to note the legal language, the requirement for witnesses, and the obvious intent. We point out this happening, emphasize that it does not even protect the institution, and urge that the practice stop.

Second, those who have been formulating informed consent rituals have not paid sufficient attention to the injury that may be caused by the ritual itself. We point out, and our respondents agree, that harm may result from ill-considered offerings of "information." The harm may take the form of suggested symptoms, induced anxiety, panic-related accidents, or serious physiological reactions. The respondents would argue that all individuals have a right to this information, and that all must receive it. But does a right to harm people exist? The right of free speech has, in American legal and ethical thinking since Holmes, been specifically held to deny the right to cry "fire" in a crowded theatre. Thus, the action of unnecessarily evoking anxiety reactions which can lead to physical harm cannot be a "right"; it is this property of present informed consent rituals that we criticize.

The consent form is inescapably a part of the experimental procedure. If it has potential for harm, the subject must be warned against this possibility just as surely as against the other hazards of an experiment. Current consent form rituals constitute human experimentation, but

oddly enough they have not been subjected to as rigorous control as other forms of human experimentation. Who is going to watch the watchdog?

What, then, shall we tell our subject? "Full disclosure" is often naïvely equated with "full knowledge." In point of fact, more comprehension is generally achieved by transmission of smaller amounts of clearly stated information than by prodigious quantities of "fine print." "Full access" is a more reasonable approach, and is the one which we urge. For example, a consent form might in two or three sentences outline the experiment and accurately define the expected level of risk in terms of a universally understood referent. (As dangerous as . . . the drawing of blood, a tonsillectomy, an airplane trip.) The reverse of the form, or a separate booklet, a copy of which the subject would retain, could contain all additional information that might be desired.

Nothing should be withheld from those who wish to know it. Similarly, nothing should be forced down the throats of those who do not wish to know. For those individuals who choose to know all, there are numerous ways in which information about potential adverse side effects can be presented to them. Whatever way is chosen, it is wise to include a discussion of the placebo effect and its potential for adverse reactions, since this may mitigate the adverse effects. This recommendation, of course, is one of offering access to *more* information than is currently the custom.

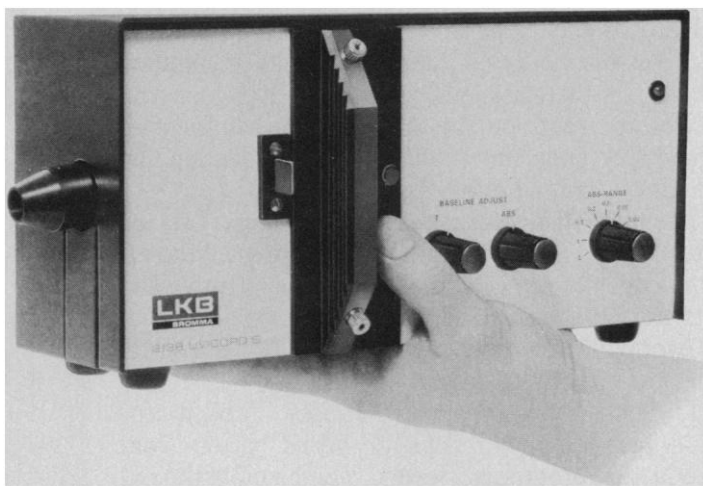
We closed our editorial by noting that in some instances subjects might be at greater risk from their self-appointed guardians than from the experiment; it was precisely individuals such as our respondents that we had in mind. They would not allow the risks of informed consent to be considered; this, they say, is "mischievous." They reflexly defend actions alleged to be in defense of a fundamental right without considering whether such actions actually defend or threaten the right of individuals to determine what will be done to their minds or bodies. These obtuse advocates of full information unfailingly argue that "more is better"; they argue for protection of the subject even as their rituals increase that subject's peril. Human beings have a right to access to information that will affect them, but they simultaneously have the right to choose when they have had enough.

JAMES F. FRIES  
ELIZABETH F. LOFTUS

*Center for Advanced Study  
in the Behavioral Sciences*

17 AUGUST 1979

## A handful of good reasons why you should monitor HPLC at 206 nm



Heart of LKB's new Uvicord<sup>®</sup> S UV-monitor is an RF-excited gas discharge lamp with an intensity at 206 nm that is orders of magnitude higher than any deuterium lamp. High photon flux reduces noise, typically to <1% at 0.005 AUFS at 206 nm so that what other instruments lose in the background, the Uvicord S monitor brings up strong and clear. You can thus pick out compounds which absorb only poorly at longer wavelengths—sugars, lipids, steroids, terpenes, alkaloids, nucleotides, non-aromatic peptides among them. And because the high intensity 206 line has a bandwidth of only 0.2 nm, linearity and stability are outstandingly good even on the slopes of absorption peaks.

But there are *still more advantages* to using the Uvicord S monitor:

- 8 $\mu$ l cell volume means high chromatographic efficiency
- you can monitor at 254 and 280 as well as at 206 nm
- dual sensitivity output lets you spot small peaks without losing large ones off scale
- the LKB lamp lasts three times as long as Zn lamps and 12 times as long as D<sub>2</sub> types
- and the new Uvicord unit (*shown above in its entirety*) mounts on a ring stand to occupy minimum bench space.

A premium UV monitor: But not a premium price. It's well within the reach of everyone. For full details, contact LKB today.

**LKB**

LKB Instruments Inc.  
12221 Parklawn Drive, Rockville, MD 20852  
301: 881-2510

Circle No. 217 on Readers' Service Card

38A-308



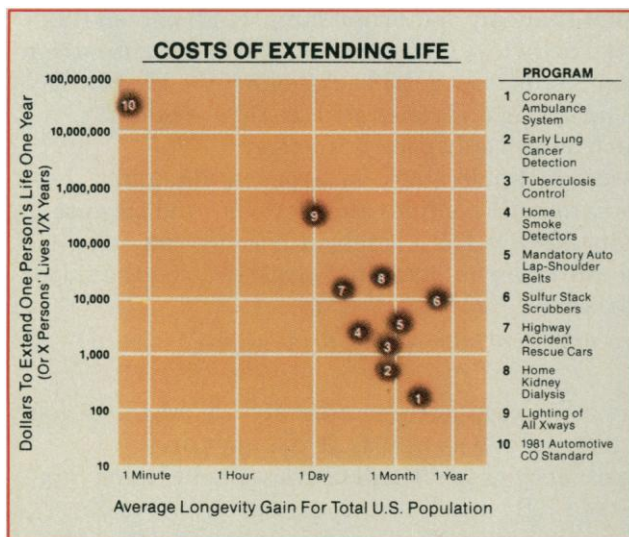
What's the fairest way of allocating the nation's limited funds to reduce various risks to human life and health? A loaded question, to be sure.

One way of evaluating a given risk-reduction program is to compare estimated costs with expected benefits, both measured in dollars. But this kind of analysis is controversial. For one thing, it requires placing a price on life itself.

Here at the General Motors Research Laboratories, societal analysts have developed a method which avoids that problem completely. It focuses on longevity and rests on the simple logic that since all life inevitably ends, no amount of risk reduction can *save* lives . . . only *lengthen* them.

The method involves using the extensive data for all categories of mortality risks and determining the effect on longevity of each category independently. The results can be summarized for each risk by the equation: Average Years Of Longer Life = 0.2 x Annual Deaths Per Million Population.

This equation serves two purposes. First, it provides a perspective of days or years gained from risk-reduction programs. Second, combined with cost estimates, it helps rate the effectiveness of those programs.



To illustrate its utility, we performed a study to compare the cost-effectiveness of several medical, environmental, and safety programs presently under serious consideration. The chart above shows the extreme variation in the costs of extending life by implementing those options.

Through such unbiased comparisons, policy-makers can obtain a clearer picture of which programs offer the greatest potential gain for a fixed budget and, thereby, have a better basis for decision.

## How to figure the cost of living ...a longer life.



**General Motors  
Research Laboratories**  
Warren, Michigan 48090

# AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

*Science* serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

## Editorial Board

1979: E. PETER GEIDUSCHEK, WARD GOODENOUGH, N. BRUCE HANNAY, MARTIN J. KLEIN, FRANKLIN A. LONG, NEAL E. MILLER, JEFFREY J. WINE

1980: RICHARD E. BALZHISER, WALLACE S. BROECK-ER, CLEMENT L. MARKERT, FRANK W. PUTNAM, BRYANT W. ROSSITER, VERA C. RUBIN, MAXINE F. SINGER, PAUL E. WAGGONER, F. KARL WILLENBROCK

## Publisher

WILLIAM D. CAREY

## Editor

PHILIP H. ABELSON

## Editorial Staff

*Managing Editor* *Business Manager*

ROBERT V. ORMES

HANS NUSSBAUM

*Assistant Managing Editor*

*Production Editor*

JOHN E. RINGLE

ELLEN E. MURPHY

*News Editor*: BARBARA J. CULLITON

*News and Comment*: WILLIAM J. BROAD, LUTHER J. CARTER, CONSTANCE HOLDEN, ELIOT MARSHALL, DEBORAH SHAPLEY, R. JEFFREY SMITH, NICHOLAS WADE, JOHN WALSH. *Editorial Assistant*, SCHERRAINE MACK

*Research News*: BEVERLY KARPLUS HARTLINE, FREDERICK F. HARTLINE, RICHARD A. KERR, GINA BARI KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON. *Editorial Assistant*, FANNIE GROOM

*Consulting Editor*: ALLEN L. HAMMOND

*Associate Editors*: ELEANORE BUTZ, MARY DORFMAN, SYLVIA EBERHART, JUDITH GOTTLIEB, RUTH KULSTAD

*Assistant Editors*: CAITILIN GORDON, LOIS SCHMITT

*Book Reviews*: KATHERINE LIVINGSTON, *Editor*: LINDA HEISERMAN, JANET KEGG

*Letters*: CHRISTINE KARLIK

*Copy Editor*: ISABELLA BOULDIN

*Production*: NANCY HARTNAGEL, JOHN BAKER; YA LI SWIGART, HOLLY BISHOP, ELEANOR WARNER; MARY MCDANIEL, JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN

*Covers, Reprints, and Permissions*: GRAYCE FINGER, *Editor*: CORRINE HARRIS, MARGARET LLOYD

*Guide to Scientific Instruments*: RICHARD SOMMER

*Assistant to the Editors*: RICHARD SEMIKLOSE

*Membership Recruitment*: GWENDOLYN HUDDLE

*Member and Subscription Records*: ANN RAGLAND

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321. Cable: *Advancesci*, Washington. For "Instructions for Contributors," write the editorial office or see page xi, *Science*, 29 June 1979.

BUSINESS CORRESPONDENCE: Area Code 202. Membership and Subscriptions: 467-4417.

## Advertising Representatives

*Director*: EARL J. SCHERAGO

*Production Manager*: MARGARET STERLING

*Advertising Sales Manager*: RICHARD L. CHARLES

*Marketing Manager*: HERBERT L. BURKLUND

Sales: New York, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-DE-7-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); DORSET, VT. 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581)

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone: 212-730-1050.

## Synthetic Chemicals in South Africa

Much has been written about various methods of obtaining synthetic fuels. But the South African efforts, although mentioned, have not received as much attention as they merit. The Sasol (South African Coal, Oil and Gas Corporation) installation is the largest synfuel plant based on coal operating anywhere. It converts an inferior high-ash (35 percent) coal into a broad spectrum of products. These may include ethylene, propylene, butylene, gasoline, and long straight-chain alcohols and hydrocarbons. The Sasol plant has been operating for about 24 years. During that time efficiency has increased and much has been learned about control of products. Sasol is a profitable operation while selling gasoline at the refinery gate for about 50¢ a gallon (14¢ a liter).

South Africa has substantial deposits of coal but no oil, and it obtains 75 percent of its energy from coal. The plant at Sasolburg is located on a huge coal field. Sasol I, the existing synthetics plant, is part of a versatile chemical complex that supplies much of South Africa's needs for materials such as nitrogen fertilizers, plastics, and pipeline gas. Consumption of coal at Sasol is 5 million tons a year. Coal is gasified in Lurgi reactors with steam and oxygen at total pressures of about 20 atmospheres. Principal products are H<sub>2</sub>, CO, CO<sub>2</sub>, and CH<sub>4</sub>. The key components are H<sub>2</sub> and CO. Their ratio can be adjusted by varying the amounts of H<sub>2</sub>O and O<sub>2</sub> used in the gasification. Constituents present in addition to the major gaseous products include NH<sub>3</sub>, H<sub>2</sub>S, and other sulfur-containing substances. To purify the raw products the gas is cooled, condensing out water and phenolic-type substances, and the remaining gas is passed through three absorption trains employing very cold methanol. This removes essentially everything except H<sub>2</sub>, CO, and CH<sub>4</sub>. Sulfur abundance in the purified gas is less than 1 × 10<sup>-8</sup>. This guarantees relative freedom from sulfide poisoning of catalysts and a low sulfur content in the final products. Reactions between H<sub>2</sub> and CO can give rise to an enormous number of products. The outcome depends on the initial concentration of H<sub>2</sub> and CO, pressure, temperature, and catalysts employed. The South Africans have made substantial discoveries about formulations and performances of catalysts. However, ultimates in specificity have probably not been reached.

When the plant was first operated in 1955, very great problems were encountered. All segments of the plant had been tested successfully on a pilot scale. But the full-scale synthetic part did not function as expected, and 5 years of discouraging struggles followed. Today, the plant performs well above its design capability.

In October 1973, when the international price of oil was raised, South Africa began intensified efforts to cut its dependence on imports. A large-scale synthetics plant, Sasol II, designed principally to produce gasoline, was authorized. This will be coming on-stream in 1980. When the Shah of Iran was deposed, oil from that country was no longer directly available. South Africa was forced to go to the spot market and pay high prices. Very quickly an additional major synthetics plant was authorized. The two installations, which are designed for zero emission of liquid wastes, will produce more than 100,000 barrels of hydrocarbon liquids a day and will supply more than half South Africa's consumption. Both installations will probably be in full production by 1984. Construction costs will total about \$7 billion. Considering South Africa's gross national product and energy consumption, its effort is comparable to a \$300-billion crash program for the United States.

The South African synthetic fuels program is well designed to fit their particular needs. Our needs and opportunities differ. We have heavy oils, tar sands, and oil shale. A number of schemes for direct hydrogenation of coal are being developed. Efforts to use bioenergy are being expanded. However, if we wish to obtain synthetic liquids quickly, on schedule, and at predictable costs, we might do well to look closely at the extensive South African experience.—PHILIP H. ABELSON



# Calculating the mean weight or net weight of 48 weighed samples takes time.

## On a Sartorius, it takes 1 second.

On other scales or balances, determining the average weight of 48 individually-weighed samples takes time. It may also take a pad and pencil, an adding machine or a calculator.

On a new Sartorius MP Balance, the same determination takes only seconds. After each sample weighing, simply press a single key on the Sartorius keyboard programmer. When all samples have been weighed, press the recall keys for instant display of the mean weight or the number of samples weighed. If printed results are required, simply connect the balance to an inexpensive Sartorius Printer.

The memory capability of the new Sartorius MP Balances permits the determination of net or fill weights by automatically deducting tare or container weights. Automatic mean weight and net weight determinations make these balances ideally suited for the weighing of pharmaceuticals, cosmetics, packaged foods, electronic com-

ponents, industrial parts, routine packaging and filling, and numerous other applications.

Utilizing built-in microprocessors, Sartorius MP Balances with optional plug-in keyboard programmers are today's most advanced and versatile electronic weighing instruments. They are available in single range and dual range models with a weighing range/readability from 0-160g/0.001g to 0-30,000g/1.0g.

For literature, just write: Sartorius Balances Division, Brinkmann Instruments, Inc., Cantiague Road, Westbury, N.Y. 11590.

### New Sartorius MP Electronic Balances with plug-in keyboard programmers.

**sartorius**



Circle No. 163 on Readers' Service Card