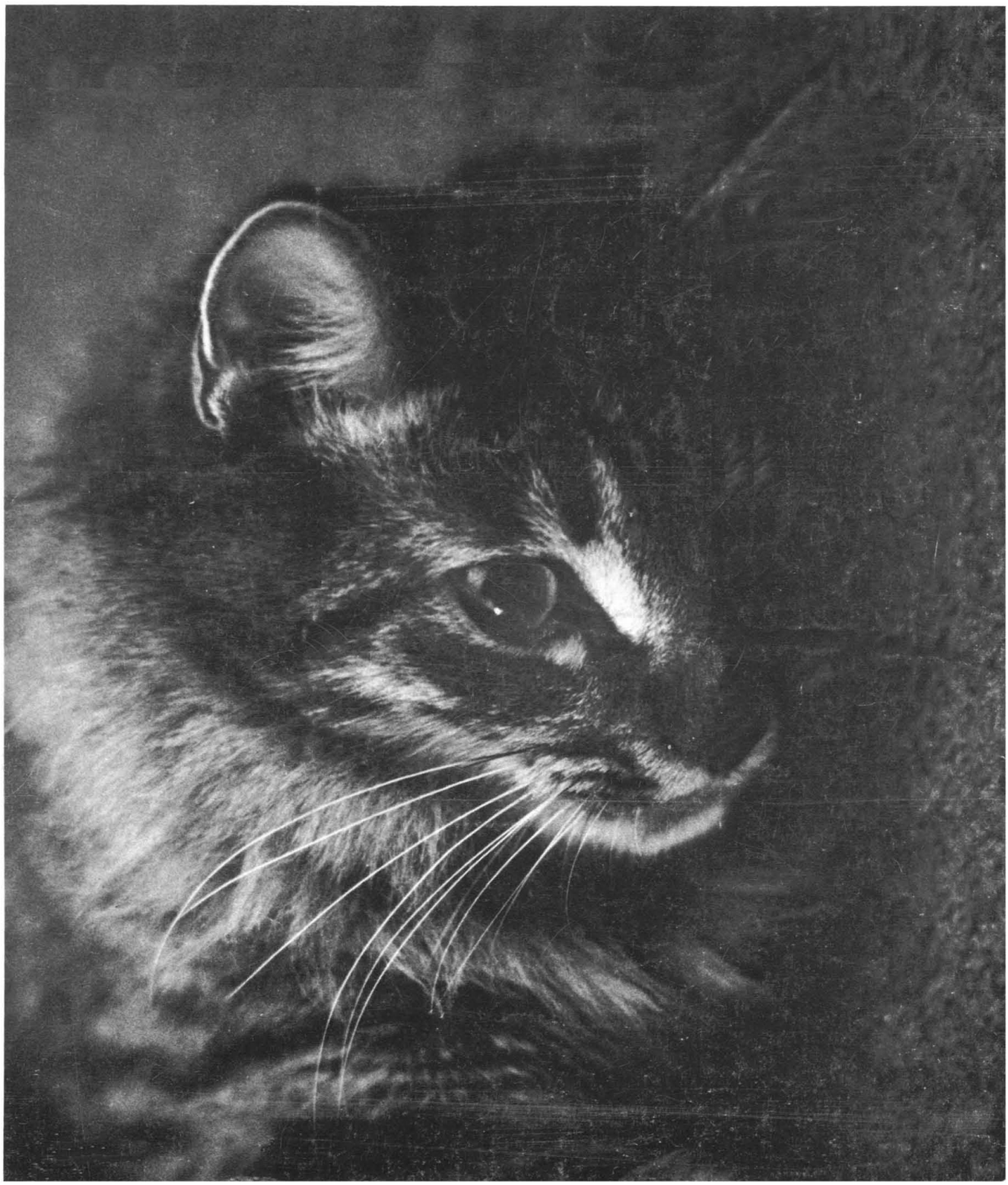
SCIENCE

10 April 1970

Vol. 168, No. 3928

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



754.8367 z temporary
5.336 845 815 05 y accumulate
33.50 x keyboard

Dynamic range 10^{-98} to 10^{99}, nearly 200 decades. Observation of math operations on 3 displayed registers. Up to 32 more registers for data storage.

TO POLAR

Complex and vector arithmetic simplified with coordinate transformation keys, rectangular-to-polar and vice-versa, in milliseconds.

tan x

Trig functions covering all quadrants and any size angle in degrees or radians.

$x \leftarrow ( )$

Introducing the HP 9100B to give you a choice of basic calculators. Provides additional internal memory and programming capability.

STEP PRGM

Edit programs easily. Single-step through programs to check and de-bug. Address an individual step and make corrections without re-entering the entire program.

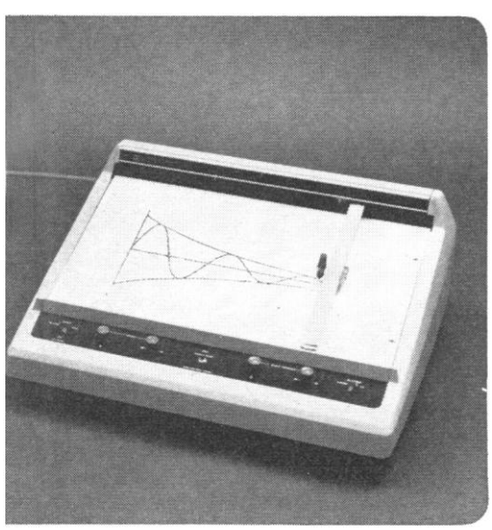
Program from the keyboard. Record and store up to 392-step programs on credit-card size magnetic cards for repeated use.

▲SUB▼ RETURN

Branching and looping flexibility provided by "IF" keys expands programming capability. Single-key direct sub-routine call.

The Emancipator...

start of the small computing system!



090/1

HEWLETT hp PACKARD

HP CALCULATOR SYSTEM 9100

It all starts with the HP 9100A calculator... and grows from there. In capability... not in size.

In fact, you can fit the entire HP System 9100 on your desk. It's the personal computing system that puts immediate answers to big computing problems right at your fingertips.

If a picture is worth a thousand numbers, add a plotter. See the solutions being plotted as fast as your problem is being solved.

Need printouts? Get the quiet printer that operates in an office or lab environment without disturbing you, or your neighbors.

You also get an extensive and growing library of applications oriented programs.

But the HP System 9100 is not resting on its laurels. Now you have a choice of basic calculators for your small computing system.

HP is adding the 9100B calculator for those of you who want even more memory and programming power.

The addition of 16 more storage registers doubles the programmable memory to 392 program steps. And, the ability to call subroutines directly gives you more efficient use of this extra memory.

Just pick the calculator that best suits your needs. Plug in the peripherals and you are ready to go. The computing power of your basic system can continue to grow to meet your changing requirements. Additions, like the upcoming memory extender, will be compatible with either calculator.

Stretch your computing dollar with the personal computing system that has learned to live on a small budget. Put this system to work for you now. Just call your local HP Calculator Salesman, he will have the HP System 9100 on your desk faster than you thought possible.

Or, write to Hewlett-Packard, P.O. Box 301, Loveland, Colorado 80537. In Europe: 1217 Meyrin-Geneva, Switzerland. Prices: HP 9100A Calculator $4400; HP 9100B Calculator $4900. Peripherals; HP 9120A Printer $975; HP 9125A X-Y Plotter $2475. Lease/rental programs start as low as $1.50/computing hour, based on average usage.

10 April 1970
Vol. 168, No. 3928

SCIENCE

SCIENCE is published weekly on Friday and on the fourth Tuesday in September by the American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Now combined with **The Scientific Monthly®**. Second-class postage paid at Washington, D.C. Annual subscription $12; foreign postage: Americas $3; overseas $5; single copies, 50¢ (back issues, $1) except **Guide to Scientific Instruments** and the 30 January issue, which are $3 each. School year subscription: 9 months, $9; 10 months, $10. Provide 4 weeks notice for change of address, giving new and old address and zip codes. Send a recent address label. SCIENCE is indexed in the **Reader's Guide to Periodical Literature**.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Adult cat, whose brain can code the concept of number. Cells in cortical association response areas responded to the numbers 2, 5, 6, and 7 in a numbered series of stimuli. See page 271. [Model, "Saturday" Finger; Gary Laurish Photography, Washington, D.C.]

Scientist or statistician? Some new computer developments are changing things for the better

To the laboratory scientist, the promise of the computer is relief from a growing burden of rather boring statistical work. He is much less interested in the computer's nanosecond-speed and the bit and word-size of its memory than in its ability to accumulate data, plot graphs, make long calculations and generally perform the non-creative tasks that increasingly are reducing his effectiveness as a scientist.

Given the chance, the computer can live up to its promise. But in all too many laboratories, the computer doesn't even stand the chance of a trial because it creates new problems that some scientists consider to be worse than the old. Chief among these is the complexity of putting the computer to work in the laboratory—programming it, mastering the instrument-computer and the man-machine interfaces—which, to the scientist, is often a greater drudgery than the manual data gathering and calculations that the computer eliminates.

Two more or less recent advances in technology will make the computer more readily acceptable to the reticent scientist. The first is the small, instrument-oriented digital computer, a relatively low-cost ($10,000-$20,000) machine with easy-to-use controls, often pre-programmed to do a specific job . . . as in the lunar sample analysis experiment described later. Second is the growing popularity, at lower and lower cost, of shared-time computer leasing, which reduces the physical presence of the computer in the lab to nothing more complex than a typewriter-like keyboard. When coupled with the availability of packaged programs developed by instrument manufacturers for a specific analytical purpose—as in the simulated distillation article described next—shared-time computers will satisfy increasingly larger numbers of scientists.

In both cases, the scientist can capture the advantage of the computer without suffering its complications. Use of the computer requires nothing more complex than answering a computer-initiated dialogue in English and mathematical terms that are already familiar to the analytical technique in question . . . and entering the answer on a keyboard that requires no more than a "hunt and peck" typing skill.

Shared-Time Computer Helps GC Simulate Distillation

A far cry from the alembic used by the 16th century alchemist, the artful glassware used by the modern oil chemist for True Boiling Point (TBP) distillation nevertheless employs the same basic technique: boil and condense. To this day, TBP distillation remains the only accepted way to establish the basic marketing specification of petroleum products . . . and it leaves a lot to be desired. Those who refine petroleum products don't like it because it takes so long: TBP distillation of a wide-boiling distillate can take as long as 100 hours, and the results are useless in controlling the operation of a refinery. Those who buy petroleum products don't like it because the method is not very reproducible, especially as it applies to the initial and final boiling points. Those who perform the distillation don't like it for both of these reasons and because the procedure itself is a long and boring task.

A group of scientists at HP's Avondale Division have devised a completely automatic method that employs gas chromatography (GC) to simulate distillation and produces boiling point distribution data more precisely and in much less time—about 10 minutes—than TBP distillation. The new method employs the HP 7600A Chromatograph System which is capable of automatic unattended operation from sample measurement and injection through GC analysis and digital readout of integration data.

The recipe for simulated distillation with the 7600A is relatively simple. After installing a non-polar column of limited efficiency (most of the methyl-silane silicone rubber phases are satisfactory), set the GC for a linear program of 6 to 10°C/minute starting at −20°C, load the sample tray with as many as 36 different calibration and analytical samples, even of widely diverse boiling ranges up to 1000°F . . . and push the *start* button: the rest is automatic.

The 7600A automatically injects the samples and prepares a punched tape record of the GC retention time and area measurements at precise time intervals. Complete sets of programs provided with the 7600A enable any of the principal time-sharing computer services (including the HP 2000A Time-Shared System) to read the punched tape data, determine the initial and final boiling points of each sample, assign boiling temperatures to each data point and print out the analysis report of boiling point distribution of each sample at 1% increments.

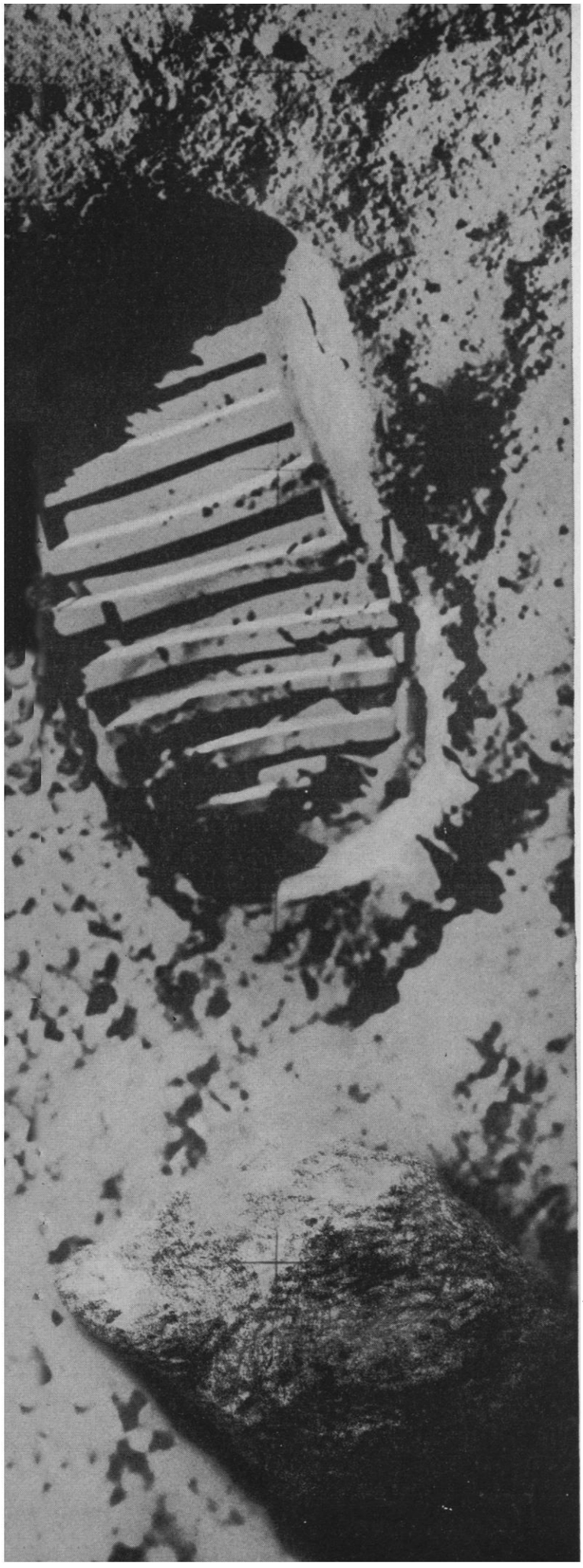
No knowledge of computer programming is required by the analyst. At each stage of the computer-performed calculations, the computer asks for the information it requires and the operator answers by typing the requested number or word on the time-share terminal keyboard.

The precision of the 7600A Simulated Distillation method with wide boiling range samples is greater than is possible by any distillation method. Its speed—an average of 10 minutes per sample—completely outclasses distillation methods.

This new automated Simulated Distillation method is examined in much more meaningful detail in Vol. 2, No. 3 of *Analytical Advances*. Request your copy today.

Dedicated Computer Extracts hidden information from Lunar sample

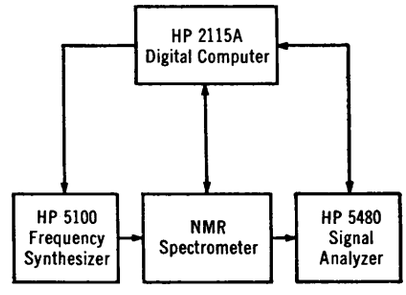
Some of the most respected scientific teams in the U.S. and eight foreign countries are performing analytical investigations on the lunar material returned to earth by the Apollo 11 crew. Among the 100-odd investigations scheduled by NASA, a nuclear magnetic resonance (NMR) analysis will be conducted by a Jet Propulsion Laboratory team headed by Dr. S. L. Manatt. Its goal is to characterize hydrogen nuclei in lunar material and attempt to establish whether any of it can be traced to free or crystalline water molecules presently on the moon's surface. The JPL scientists will also be on the lookout for heavy hydrogen whose presence will allow some conclusions about the history of the moon's surface and about the effect of the solar wind. A study



of oxygen-17 may give them important clues about the current chemical environment of the moon (from surface samples) and about the presence of a lunar sea or ocean in the distant past (from core samples).

Present-day commercial NMR spectrometers are capable of accomplishing, unaided, the work assigned to the JPL team with a creditable degree of success. But when you're analyzing samples that cost about a million dollars a gram to acquire, you're not satisfied with anything short of the best possible performance from your analytical instruments.

In the JPL team's quest for enhancing NMR sensitivity, they devised a system that combines the NMR spectrometer with a frequency synthesizer and signal analyzer under the control of a small digital computer, the HP 2115A, dedicated to this task alone.



The computer-controlled system extracts very weak NMR signals from heavy noise, enhancing instrument sensitivity as much as 100 times. It also performs fast Fourier Transforms of the NMR signal, converting it from time to frequency domain, for a further increase in sensitivity of another order of magnitude.

Here's how it works: the computer digitally sweeps both the frequency synthesizer and signal analyzer through programmed frequencies. Synthesizer output excites the NMR spectrometer which develops noise-covered resonance spikes for each nucleus in the lunar sample; under computer control, the frequency synthesizer also shifts NMR excitation between the resonance and transition frequencies of the nucleus under observation, thereby permitting measurement of relaxation or resonance decay times. The NMR output signal is fed to the signal analyzer which extracts the data from the noise and presents a calibrated display of the average signal at all times. The computer then processes the waveform, converts it from time to frequency domain by Fourier transformation and displays the result immediately in analog as well as digital form. End results of computer-controlled signal averaging and Fourier Transform is to increase spectrometer sensitivity as much as a thousand-fold. (Photo courtesy of NASA.)

Detailed information on HP Signal Analyzers and Computers is available on request. Write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

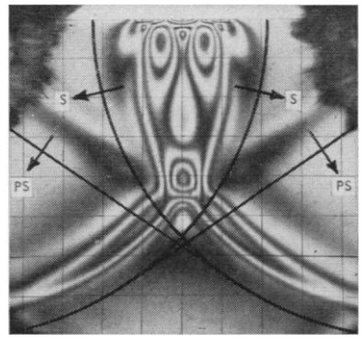
ANALYTICAL INSTRUMENTS

00971

Stress and stimulation

One can find stimulation and satisfaction in considering how the shape of an object affects the direction and magnitude of stresses induced in it by external mechanical forces.

A problem happens to present itself, and the latent interest leaps into flame. First, the equations. Next, the excitement of confirming the theory by observing and photographing photoelastic stress analysis in transparent cross-sectional models. Which may require a note to Eastman Kodak Company, Dept. 412-L, Rochester, N. Y. 14650, demanding Kodak Job Sheet No. 13 by return mail.



Later on, one applies for membership in the Society for Experimental Stress Analysis, 21 Bridge Square, Westport, Conn. 06880, perhaps eventually wins election to its Executive Committee.

ticles to the same journals as now. Journals would be available in libraries on microfilm. Exceptions could be made for remote libraries if necessary. Editorial processing and refereeing would be conducted as it is done now until the article is in acceptable form. At this point, the manuscript would be typed on a justifying typewriter, then copied on microfilm, and these micro copies would be mailed to all library subscribers who must store the whole journal.

3) Titles and brief abstracts or keyword lists would be printed in an inexpensive format on newsprint and sent to individual subscribers. This weekly newspaper would contain all journals under broad headings, such as "Physical Sciences," "Biological Sciences," "Earth Sciences," and so forth. The divisions can be as general or restricted as practical. Each weekly would contain a numbered postcard for ordering papers by circling appropriate numbers. The individual gets only those articles he wishes to keep, and he can store them to suit his personal needs—by subject, author, journal, or what-have-you.

4) The individual subscriber would pay in advance for the information service, which can include a small number of papers at no extra cost and the right to order larger numbers in advance at an extra charge. If the selection of articles is done by perforating a computer card, the charges can be based on the number of pages ordered, by appropriate coding at the publishers. Excess orders can be billed as "arrears" on next year's subscription form, in the same manner as we pay for gas and electricity.

5) For libraries which cannot store microfilm, it should be possible to order bound sets of articles corresponding to an issue. If these are presented in a plastic clamp binder, the cost of ultimate bookbinding might be slightly less than at present.

If publication were carried out on this basis, the individual subscriber would get just what he paid for, the use of paper would correspond exactly to the need, bookshelves would be less cluttered, publication charges to authors' institutions could be reduced about 50 percent, and subscription costs to individuals and libraries might be substantially reduced. Subscribers' computerized interest profiles could be introduced as soon as the demand warranted and would be available at an extra charge (I don't believe any scientist should be deprived of the joy of getting a research idea by the chance juxtaposition of two titles or abstracts as he searches the current journals. If the literature has become so voluminous that we have no time to browse, we could at least let our fingers browse through our weekly abstracts).

Some of the mechanisms for adopting such a scheme are already here. *Current Contents* sends out a weekly list of published papers giving authors' addresses. This has the major drawback in that it appears *after* the article has gone through the lengthy processes of typesetting, proofreading, lockup and makeready of letterpress, and mailing. The above procedure would have the title and keywords or abstract in the readers' hands within a few weeks of acceptance by the editor, so they could read an edited and refereed copy of the paper within 2 or 3 months of its submission in most cases. If the reviewing process is inordinately long, the reader should probably be glad he doesn't have to read the original unrefereed manuscript.

A system almost identical to the above was proposed to me and to all his friends and acquaintances by my late colleague, Isador Fankuchen, about 15 years ago. The trends were clear even then, and unless we wish to be buried under a dual mound of unedited trash and elegant and unread archives, we had better all get together soon and do something about it. I have talked to many people about it and found that scientists range from mild interest to enthusiasm, but I have yet to meet a publisher's representative who favors it.

EPHRAIM BANKS
Department of Chemistry,
Polytechnic Institute of Brooklyn,
333 Jay Street, Brooklyn, New York

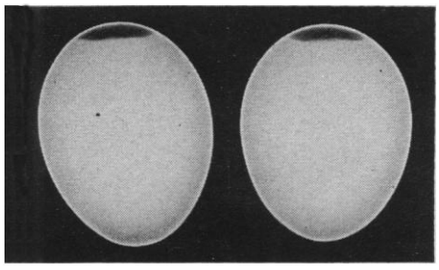
Egg Fanciers

Reynolds' letter "Well-rounded egghead" (16 Jan.) prompts me to swiftly remind your readers that, while the rounded end of a macroscopic egg indubitably "has in it the most stuff," to a considerable extent the "stuff" consists of a pocket of gas. This may be readily noted when a hard-boiled hen's egg is peeled. In addition, the quantity of gas increases with the age of the egg.

W. DAVID ENGLISH
852 South Oakwood Street,
Orange, California 92667

Reynolds is correct in stating that eggs "have two ends, a rounded one and a pointy one," but he is mistaken in saying that the latter gets there first (when laid). I have observed many bantam hens in the act of oviposition and the rounded end appears first just about as often as the pointy one.

FRED P. JEFFREY
97 Pine Street,
North Amherst, Massachusetts 01059



. . . If one can say either end of an egg is inferior, we submit that it is the blunt end that is relatively vacant and contains hot air (see illustration). We are proud to remain two pointy eggheads.

T. HEALEY
D. E. PRICE
Departments of Radiology and *Pathology, Beckett Hospital, Church Lane, Barnsley, Yorkshire, England*

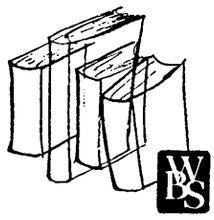
Open Letter to President Nixon

We strongly support your efforts to eradicate bacteriological weapons, and suggest that a most appropriate antidote would be to turn the activities of the Chemical and Biological Warfare services toward research that will aid in restoring a harmonious ecological balance.

The detrimental effects of the use of pesticides and chemical fertilizers have now been devastatingly demonstrated by the volume of dying birds, dying fish, dying streams, and dying lakes. Unless other means are found to replenish the soil and attack insect pests, we face an environmental catastrophe. We therefore urge you to consider the possibility of diverting the personnel and facilities of CBW to the very urgent tasks of (i) finding strains of bacteria and parasites to be used against harmful insects; and (ii) developing nitrogen-fixing bacteria that would enrich the soil without creating harmful side effects. In this way the vast experience and equipment available through CBW can be salvaged and utilized for the improvement of our environment—a "swords into plowshares" program at the biological level.

TAHIR M. RIZKI*
RICHARD W. HILL
Department of Zoology, University of Michigan, Ann Arbor 48104

* In addition, 81 people associated with the Department of Zoology signed this letter.



Current Texts in Mathematics

Ballard:
GEOMETRY
The "core" of Euclidean geometry—plane geometry to the Pythagorean theorem—is thoroughly presented in this text for the first course at the college level. It is well suited for elementary education majors, students pursuing programs in general education, and prospective secondary school teachers.

By **William R. Ballard,** Univ. of Montana.
238 pp. 178 figs. $9. January, 1970

Cooper & Steinberg:
AN INTRODUCTION TO METHODS OF OPTIMIZATION
A wide variety of optimization methods, including **classical optimization theory, linear and nonlinear programming, search techniques** and **integer programming** are discussed in this elementary text. Emphasis is on use of theory to obtain computationally feasible methods for solving optimization problems.

By **Leon Cooper** and **David Steinberg,** Washington Univ.
About 432 pp. Illus. About $13. Ready August, 1970.

Douglis:
IDEAS IN MATHEMATICS
This text, an outgrowth of the MINNEMAST program at the University of Minnesota, is designed for a one or two semester terminal course for liberal arts students or for a "content" course for prospective elementary school teachers. It is written to help teach the student the basic processes of mathematical thinking.

By **Avron Douglis,** Univ. of Maryland.
784 pp. 355 figs. $11. March, 1970

Embry, Schell & Thomas:
CALCULUS AND LINEAR ALGEBRA
Volumes I & II
Here is an introductory text which treats one-dimensional differential calculus within the framework of affine approximations and gives extensive coverage of higher dimensional calculus.

By **Mary R. Embry** and **Joseph F. Schell,** Univ. of North Carolina; and **J. Pelham Thomas,** Western Carolina Univ.
Vol. I: About 640 pp. About 125 figs. In preparation. Ready Spring, 1971.
Vol. II: About 400 pp. Illust. In preparation. Ready Spring 1971.

Epstein:
LINEAR FUNCTIONAL ANALYSIS
This brief introductory text shows how functional analysis is developed by the extraction of the underlying features common to diverse problems of concrete or "hard" analysis, and how the abstract theory derived can be applied in particular situations.

By **Bernard Epstein,** Univ. of New Mexico.
229 pp. Illus. $9.50. January, 1970.

Fairchild & Ionescu Tulcea:
SETS
An outstanding text from the standpoint of mathematical precision, this book is ideal for sophomore or junior courses on set theory. Formal systems are avoided although references are made to various axioms of set theory.

By **William Fairchild** and **C. Ionescu Tulcea,** Northwestern Univ.
About 145 pp. Illus. About $4.75. Ready June, 1970.

Fremont:
HOW TO TEACH MATHEMATICS IN SECONDARY SCHOOLS
This exciting book tells how to teach mathematics—from arithmetic to calculus—so that students not only master skills and concepts but also glimpse the power and beauty of mathematics.

By **Herbert Fremont,** Queens College of the City Univ. of New York.
571 pp. 346 figs. $10.50. January, 1969.

Gelbaum & March:
MATHEMATICS FOR THE SOCIAL AND BEHAVIORAL SCIENCES
Volumes I & II
The authors draw their examples from such applications as opinion sampling, aptitude testing, and decision theory, in this text designed to implement the recommendations of the CUPM.

Vol. I: Probability, Calculus and Statistics. 337 pp. Illus. $8.75. February, 1969. **Vol. II: Linear Algebra, Difference and Differential Equations, and Applications.** About 340 pp. Illus. In preparation. Ready Fall, 1970.

Munroe:
CALCULUS
Outstanding for a three semester sequence, this basic text presents the calculus of one variable, linear algebra, and multi-dimensional calculus. Broad coverage of ideas and techniques is emphasized rather than rigorous development of any one topic.

By **M. Evans Munroe,** Univ. of New Hampshire.
About 750 pp. About 360 figs. About $13.50. Just Ready.

Owen:
FINITE MATHEMATICS:
Mathematics for the Social and Management Sciences
Dr. Owen's text for the college freshman carefully develops the methods of finite mathematics and demonstrates how they are applied to practical problems in economics, management, psychology, etc. The text is designed for a one-year course using a non-calculus approach.

By **Guillermo Owen,** Rice Univ.
424 pp. 100 figs. $10. March, 1970. Just Ready.

For further information or 30-day approval copies write Education Department

W. B. SAUNDERS COMPANY West Washington Square, Philadelphia, Pa. 19105

10 April 1970, Volume 168, Number 3928 **SCIENCE**

Shortage of Caviar

The U.S.S.R. has assigned top priorities to armament, space, and capital goods. Only a few luxury consumer goods, such as caviar, are produced for export. But even this item is now disappearing, and its price has risen sharply.

Natural caviar is derived from the roe of the sturgeon. Most of these fish dwell in the Caspian Sea and the Volga River. Pollution of these waters has led to attenuation of the fisheries. A Novosti Press Agency release states: "Off-shore drilling operations keep expanding, and, as a result of a purification bungle and an irresponsible approach to this problem by the oil-extracting plants and refineries, the Caspian Sea . . . is becoming badly polluted. Add the industrial sewage discharged into the sea and the contamination by intensive shipping, and you will not be surprised to learn that the sturgeon catch is falling sharply." Supplementing these remarks is a passage in *Soviet Life*:* "The Caspian's prime polluter is oil. Until recently all the off-shore oil installations, which use great quantities of water, dumped the contaminated water into the sea. Hundreds of tankers carry oil derivatives across the Caspian. The holds of the tankers were cleaned en route, and the waste water emptied into the sea."

Examination of Soviet publications indicates that their water pollution problem is widespread and serious. Oils, phenols, alkalis, acids, and organic wastes are dumped in streams and lakes, and only a small fraction of plants have adequate facilities for waste treatment. A passage from *Izvestia* states, "there are more than fifteen thousand milk, butter and cheese factories and separator departments in the country . . . they consume millions and millions of cubic meters of water. The number of fish factories, tanneries, linen factories, regional food combines and industrial complexes is still greater . . . nearly all of these enterprises have no waste water purifying installations."

The Soviet government is now moving toward abating pollution, but the problem will not be solved quickly. Huge capital investments in treatment facilities are required, and construction will extend over many years. The Soviet government must also cope with its plant managers. A quotation from *Izvestia*† illustrates the problem. In a discussion of the failure of management to construct purification installations, the item says, "the Voskresensky Chemical Combine managed not to spend one kopek on this construction, although the money had been allocated. They explain how, waving their arms, the design organization did not turn over the drawings on schedule. But why did the combine director, Comrade Doktorov, instead of trying to obtain the designs, begin to fuss about to have himself relieved of all these unnecessary headaches, the installations of all kinds of filters and sediment traps?"

In commenting on this quotation, Myron Tribus pointed out that the problem of managing pollution is "universal, characteristic of all technological societies and in the end reflects the value judgments of those people who are creating the wastes." Senator Muskie summarized the matter in another way when, in speaking of the Russian and American approaches to pollution, he said, "It is not so important who owns the means of production as how they are managed."

Both the U.S.S.R. and the United States have been careless in despoiling the environment. Both now seem to be moving toward a more responsible posture. If the two nations were to compete in the clean-up process, that would be constructive. If they were to cooperate, that would be a welcome miracle.—PHILIP H. ABELSON

*A. Simonov, "Cleaning up the seas," *Soviet Life* (January 1970), p. 59. †Statement of Dr. Myron Tribus at hearing of U.S. Senate Committee on Public Works regarding S2005 and amendment 153 to the Solid Waste Disposable Act (1 October 1969), p. 813.

To handle the unglamorous chore of pipet cleaning, more labs use Nalgene pipet cleaning equipment than any other brand.

The Nalgene Pipet washer-rinser has a one-piece design with "over-the-top" water inlet that eliminates pipet cleaning problems. No back-siphoning, no siphon stall, no splash, no leakage, no tinkering to get things started. Operates with water input from 1½ to 12 liters per minute, provides different cycling speeds for washing, soaking, or rinsing. Also, Nalgene pipet baskets with recessed screens for complete drainage, and pipet jars. And, like all Nalgene Labware, this equipment is unbreakable, easy to handle and clean.

Nalgene® Labware...better all the time

NALGE
SYBRON CORPORATION

SEE US AT THE MICROBIOLOGY SHOW, BOSTON, APRIL 26-MAY 1, BOOTH #702

Order from your Lab Supply Dealer. Ask him for our Catalog or write Dept. 85161
Nalgene Labware Division, Nalge Company, Rochester, N. Y. 14602

Separation of Plant Particles

Although much of what we know about plant (or animal) metabolism has been generated from studies with isolated subcellular structures such as chloroplasts, mitochondria, and ribosomes, most investigators have had to accept a choice of either "preparative" amounts of crude suspensions or vanishing by small quantities of pure particles. Moreover, the intactness of isolated organelles has been a doubtful quality; most "chloroplast preparations" have been "class II" chloroplasts, a euphemism for stripped and swollen lamellae, devoid of stroma and limiting membrane. The discovery of peroxisomes has glaringly illuminated this unhappy state; for we suddenly find that peroxisomes, not chloroplasts, contain the catalase of green leaves, and that these same bodies, not mitochondria, are the sites of fatty acid oxidation in fatty seedlings.

No one has been content with conventional methods of particle separation and, with the new possibilities for relatively large-scale density gradient centrifugation in zonal rotors, we need no longer be limited by them. It is now possible, at least theoretically, to prepare biochemically useful quantities of all kinds of subcellular particles with defined sedimentation coefficients and equilibrium densities. In the future we should be able to specify that the particles in a chloroplast preparation have *S*-values of between 500 and 550 kilosvedbergs and equilibrium densities between 1.100 and 1.105 g/cm^3. Naturally, we should also demand ultrastructural intactness.

Toward this end a Microsymposium on the Separation of Plant Particles was held at Oak Ridge, Tennessee, 22–24 January 1970. The purpose of the meeting was to exchange practical and theoretical ideas on the separation of cellular, subcellular, and macromolecular particles from plants. In order to describe the current state of the art in selected areas of particle separation independent of the immediate application, a number of the invited speakers were concerned with animal or bacterial systems. The bias of the organizers—N. G. Anderson, R. C. Fuller, and myself—was revealed by the heavy emphasis on density gradient centrifugation in zonal rotors.

On the theoretical level, there was a recurrent theme—the relatively large size and sectorial geometry of zonal rotors have increased the feasibility of and thus stimulated interest in the direct testing of physical and mathematical models of density gradient centrifugation. S. P. Spragg (Birmingham, England) considered the design of gradients for optimizing resolution in which the volume (rather than the radial width) of a particle zone remains constant during sedimentation. Spragg asked if the diffusive flow of solute and solvent induced by a gradient must not set a lower and time-dependent limit on the volume of a particle zone. V. N. Schumaker and B. Halsall (Los Angeles) described a simple model system for measuring zone broadening due to diffusion of the sample particles. Droplet sedimentation was eliminated by incorporating a counter macromolecule in the underlying solution. Their procedure provides simple means of measuring diffusion coefficients and for evaluating additional factors that might influence zone broadening during sedimentation. H. W. Hsu (Oak Ridge and Knoxville) presented equations which predict particle behavior (position and instantaneous velocity) from the radial functions of gradient density and viscosity expressed as polynomials. His calculations should greatly facilitate the calculation of apparent sedimentation coefficients in gradients of known composition.

In the area of centrifuge techniques and hardware, G. B. Cline (Birmingham, Alabama) described recent developments with the K-series of high-speed continuous-flow rotors. Cline's proposals for increasing resolution through the use of step gradients generated considerable discussion. C. R. McEwen, E. T. Juhos, and R. W. Stallard (Palo Alto) discussed the principles and possibilities for continuous-flow fractionation with their elutriation rotor. Although the rotor is still in a developmental stage, its application to the fractionation of whole cell populations will be watched very closely. D. A. Waters (Oak Ridge), speaking of the physical and metallurgical problems of rotor design, illustrated problems of stress limits of different rotor materials by cheerful references to "catastrophic self-disassembly."

The criteria for intactness and the special problems of membrane-bound particles were emphasized by three speakers. W. Laetch (Berkeley) described the different characteristics of chloroplasts in the parenchyma as con-

trasted with those in bundle sheaths of tropical grasses and other "Hatch-Slack" plants. N. E. Tolbert (East Lansing) outlined the metabolic activities of leaf peroxisomes and some of the problems in their isolation. W. D. Bonner (Philadelphia) reported highly intact mitochondria from white potato, but concluded that "God in his infinite wisdom meant that roots were not to be ground up." The consensus from numerous informal discussions was that difficult problems remained in the recovery of pure suspensions of completely intact chloroplasts, peroxisomes, and mitochondria.

The application of zonal centrifugation to the separation of specific particles was discussed by a number of speakers: bacterial "minicells" (W. Fisher, Oak Ridge), animal nuclei of different ploidy (C. A. Albrecht, Oak Ridge), continuous-flow harvesting and separation of intact from stripped chloroplasts (D. H. Brown, Oak Ridge), separation of mitochondria from derepressed and repressed yeast (C. A. Price, New Brunswick), preparation of homogeneous viruses for vaccine production (J. L. Gerin, Bethesda; H. E. Bond, Bethesda), one-step fractionation of serum lipoproteins by density gradient flotation (M. Heimberg, Nashville), and separation of undegraded chromosomal DNA by reorienting gradient techniques (J. Lett, Fort Collins).

Among the most imaginative applications of particle separations was the proposed control of the Douglas fir tussock moth caterpillar through large-scale purification of the specific polyhedrosis virus in a K-type rotor (J. P. Breillatt, Oak Ridge).

The microsymposium and two associated workshops were sponsored by the American Society of Plant Physiologists, the University of Tennessee–Oak Ridge Graduate School of Biomedical Sciences, and the Molecular Anatomy Program of the Oak Ridge National Laboratory. Support was provided by these organizations plus the Division of Biology and Medicine of the U.S. Atomic Energy Commission, the International Equipment Company, and the Spinco Division of Beckman Instruments. The published proceedings of this microsymposium will be available from the MAN Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

C. A. PRICE

Rutgers University,
New Brunswick, New Jersey 08903

Courses

Experimental and Theoretical Analysis of Modern Characterization Methods Applied to Electronic Materials, Cambridge, Mass., 27 July–7 August. This course will deal with the available methods and techniques (their potential and limitations) for the chemical and physical characterization of materials (for electronic applications, semiconductors, magnetics, dielectrics, and others). The principles of the various characterization techniques will be discussed as they relate to the determination of trace impurities, impurity heterogeneities, crystalline structure, lattice defects, electrical carriers, and surface configuration of specific classes of electronic materials. (Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge 02139)

Anthropology for College Teachers, Boulder, Colo., 15 June–21 August. This summer institute is being offered for the 10th year and has been awarded a grant by the National Science Foundation. Is intended for 30 college and junior college teachers of anthropology whose formal training in the subject is weak. (Dr. A. J. Kelso, Director, Department of Anthropology, University of Colorado, Boulder 80302)

Theory and Practice of the Analytical Ultracentrifuge; Advances in Macromolecular Characterization, Woods Hole, Mass., 11–22 May. Material will include basic information, sedimentation velocity; boundary analysis; zonal and active enzyme sedimentation velocity, sedimentation equilibrium of enzymes, including paucidisperse systems; density gradient sedimentation equilibrium; and optical techniques. *Tuition*: $400. (Dr. David Teller, Department of Biochemisty, University of Washington, Seattle 98105)

Anatomy, Physiology, and Patient Care, Charleston, S.C., 13 July–7 August. The course is designed to familiarize the engineer with the problems involved in the delivery of medical care. The opportunity to observe the activities of the emergency room, operating room, intensive care unit, and other areas of the hospital is provided. Limited to 40 participants. *Tuition*: $500. (Mr. Thomas S. Hargest, Director, Engineering Development Section, Department of Surgery, Medical University of South Carolina, Charleston 29401)

Polymers (Characterization, Morphology, and Structure-Property Relations), Houston, Tex., 4–8 May. *Fee*: $300. (Mary B. Appleton, Office of Continuing Studies, P.O. Box 1892, Rice University, Houston, Tex. 77001)

Practicum in Histology, Boston, Mass., 24 May–5 June. An intensive program in histological techniques, including fixation, embedding, microtomy, staining, and autoradiography, is designed for doctoral level investigators. Highly recommended laboratory assistants will be considered. Limited to 12 students in order to insure maximum practical laboratory experience. (Dr. Clifford F. Youse, Director of Programs in Applied Science, Center for Continuing Education, Northeastern University, Boston, Mass. 02115)