

SCIENCE

10 April 1970

Vol. 168, No. 3928

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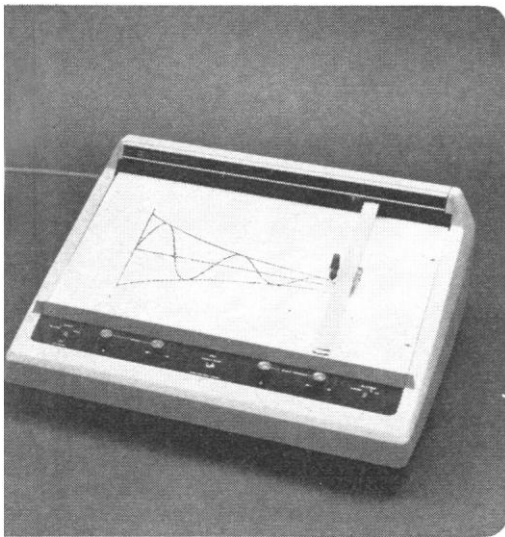


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COVER

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.]

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 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.

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 dis-

tribution 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.

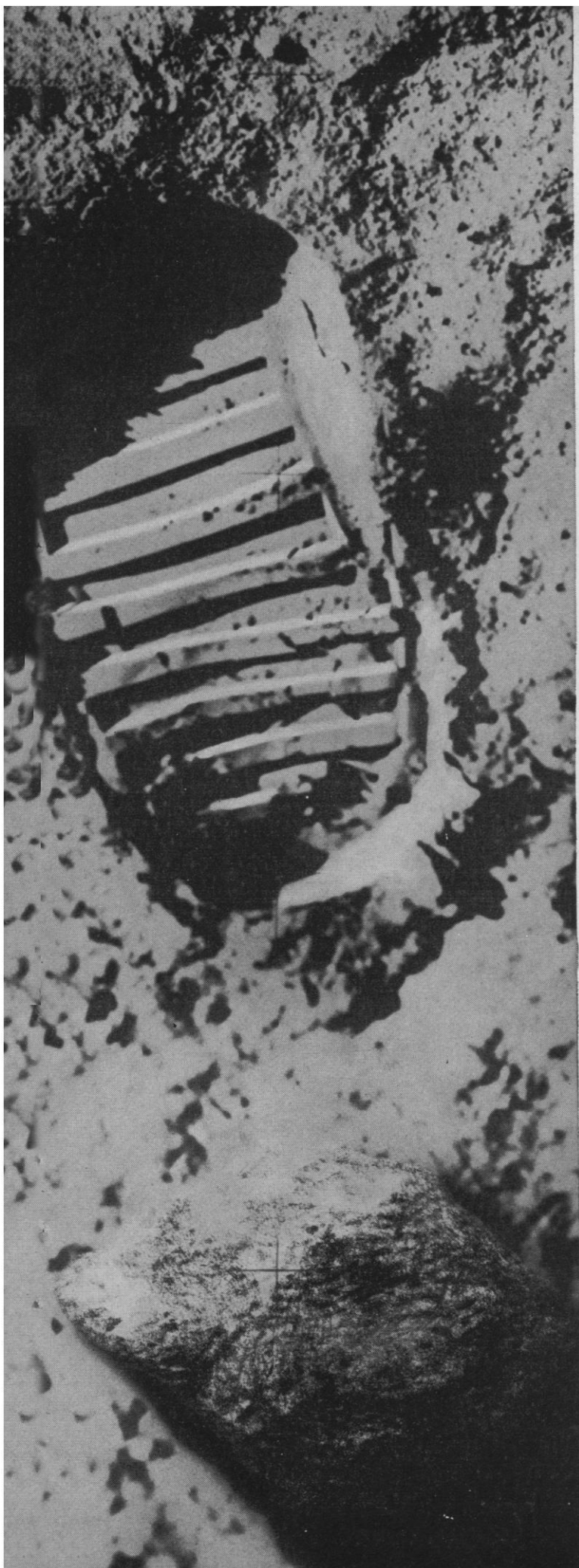
No knowledge of computer programming is required by the analyst. At each stage of the computer-performed calculations, the computer asks for the information it requires and the operator answers by typing the requested number or word on the time-share terminal keyboard.

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).

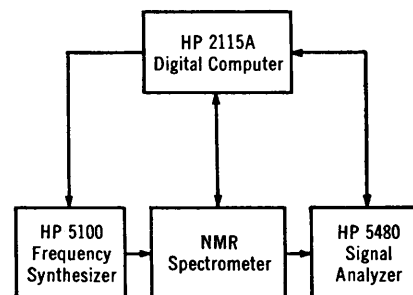
Present-day commercial NMR spectrometers are capable of accomplishing, unaided, the work assigned to the JPL team with a creditable degree of success. But when you're analyzing samples that cost about a million dollars a gram to acquire, you're not satisfied with anything short of the best possible performance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



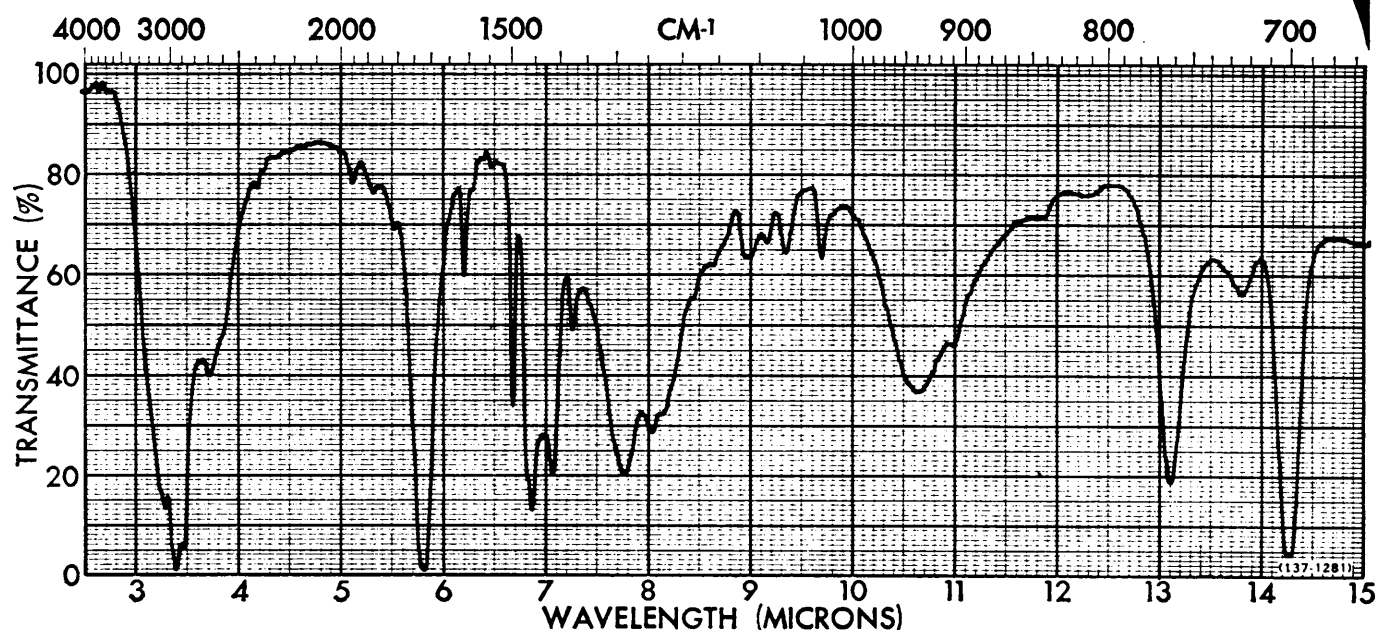
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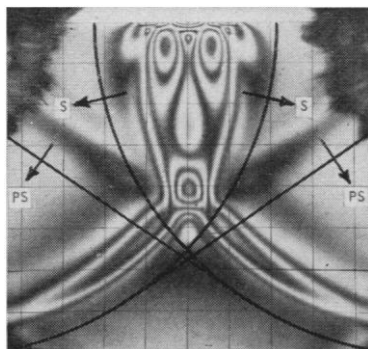
*In our opinion.

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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.



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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 book-binding 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 make-ready 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

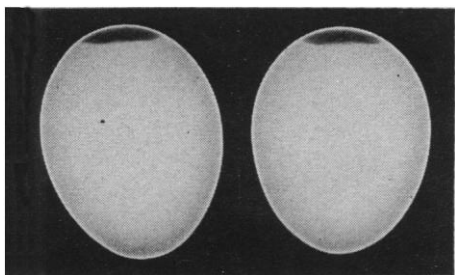
Egg Fanciers

Reynolds' letter "Well-rounded egg-head" (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 egg-heads.

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.

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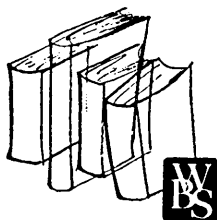
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Shortage of Caviar

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 Disposal Act (1 October 1969), p. 813.



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MEETINGS

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 ribo-
somes, most investigators have had to
accept a choice of either "preparative"
amounts of crude suspensions or van-
ishing by small quantities of pure par-
ticles. Moreover, the intactness of iso-
lated organelles has been a doubtful
quality; most "chloroplast prepara-
tions" have been "class II" chloro-
plasts, 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 mito-
chondria, are the sites of fatty acid
oxidation in fatty seedlings.

No one has been content with con-
ventional methods of particle separa-
tion 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/cm³. Natu-
rally, we should also demand ultrastruc-
tural 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 macro-
molecular particles from plants. In
order to describe the current state of
the art in selected areas of particle
separation independent of the immedi-
ate 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 centrifuga-
tion. S. P. Spragg (Birmingham, Eng-
land) 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. Schu-
maker and B. Halsall (Los Angeles)
described a simple model system for
measuring zone broadening due to dif-
fusion of the sample particles. Droplet
sedimentation was eliminated by incor-
porating a counter macromolecule in
the underlying solution. Their proce-
dure provides simple means of mea-
suring diffusion coefficients and for
evaluating additional factors that might
influence zone broadening during sedi-
mentation. H. W. Hsu (Oak Ridge
and Knoxville) presented equations
which predict particle behavior (posi-
tion and instantaneous velocity) from
the radial functions of gradient density
and viscosity expressed as polynomials.
His calculations should greatly facili-
tate the calculation of apparent sedi-
mentation coefficients in gradients of
known composition.

In the area of centrifuge techniques
and hardware, G. B. Cline (Birming-
ham, Alabama) described recent de-
velopments with the K-series of high-
speed continuous-flow rotors. Cline's
proposals for increasing resolution
through the use of step gradients gen-
erated considerable discussion. C. R.
McEwen, E. T. Juhos, and R. W. Stal-
lard (Palo Alto) discussed the prin-
ciples and possibilities for continu-
ous-flow fractionation with their elutriation
rotor. Although the rotor is still in a
developmental stage, its application to
the fractionation of whole cell popula-
tions 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) de-
scribed 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 de-repressed 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 microsposium 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 microsposium will be available from the MAN Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

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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)

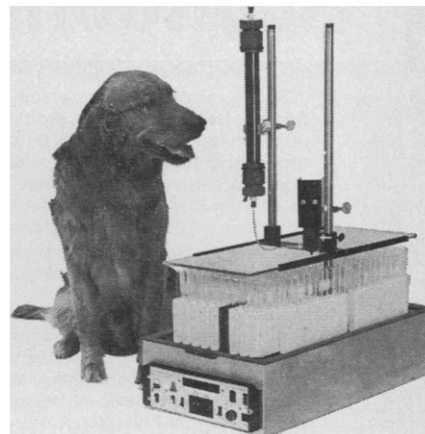
Theory and Practice of the Analytical Ultracentrifuge; Advances in Macromolecular Characterization, Woods Hole, Mass., 11-22 May. Material will include basic information, sedimentation velocity; boundary analysis; zonal and active enzyme sedimentation velocity, sedimentation equilibrium of enzymes, including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

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