SCIENCE

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Volume 193, No. 4250

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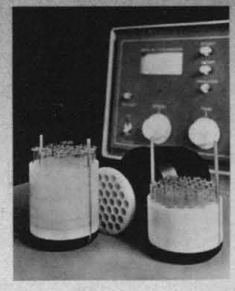

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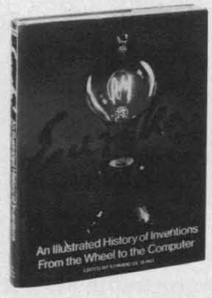

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SCIENCE

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COVER

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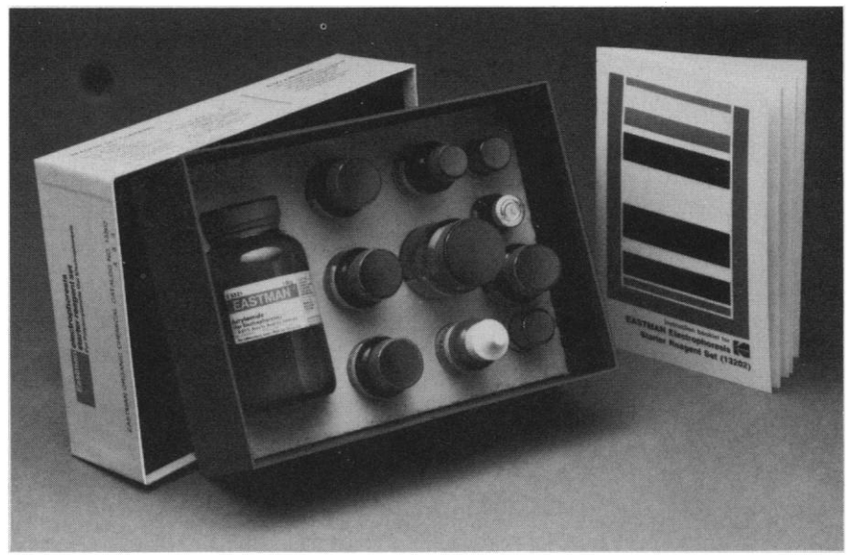

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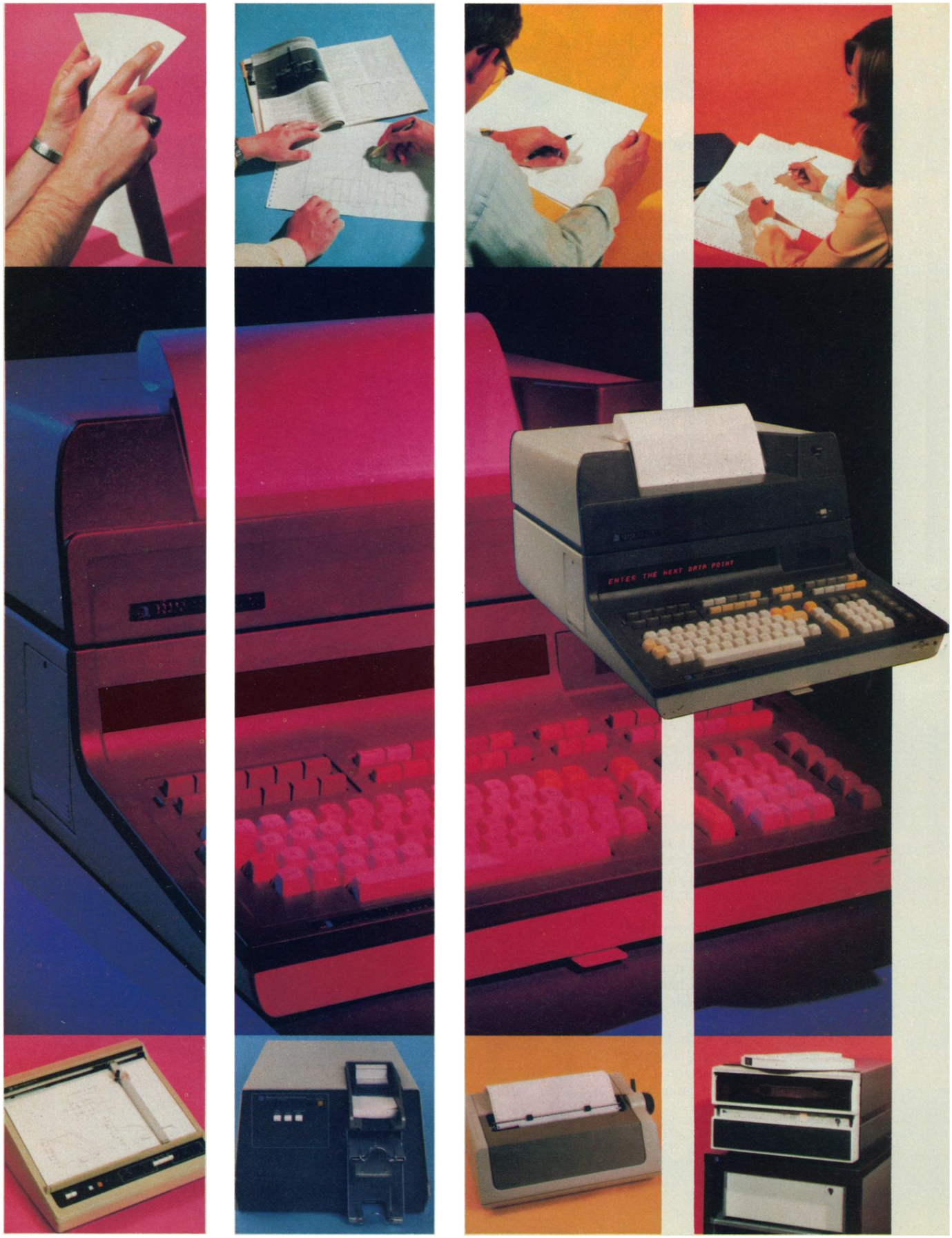

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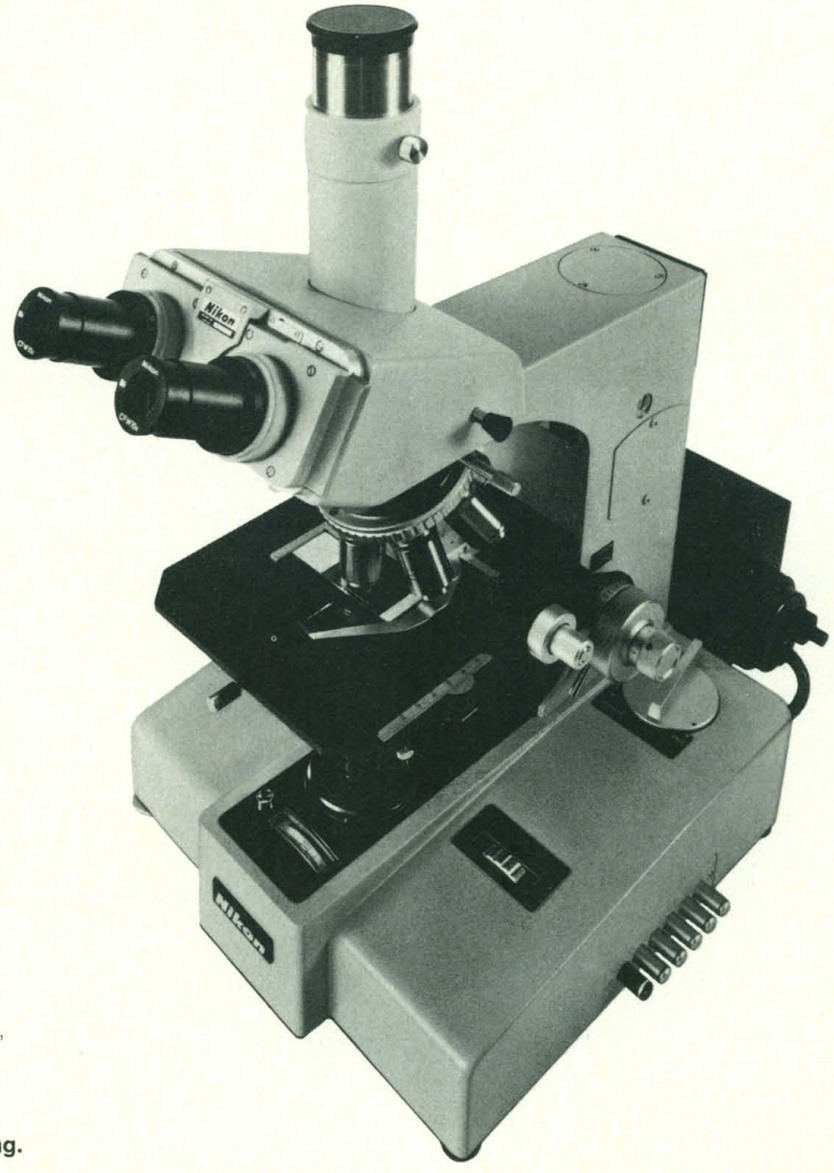

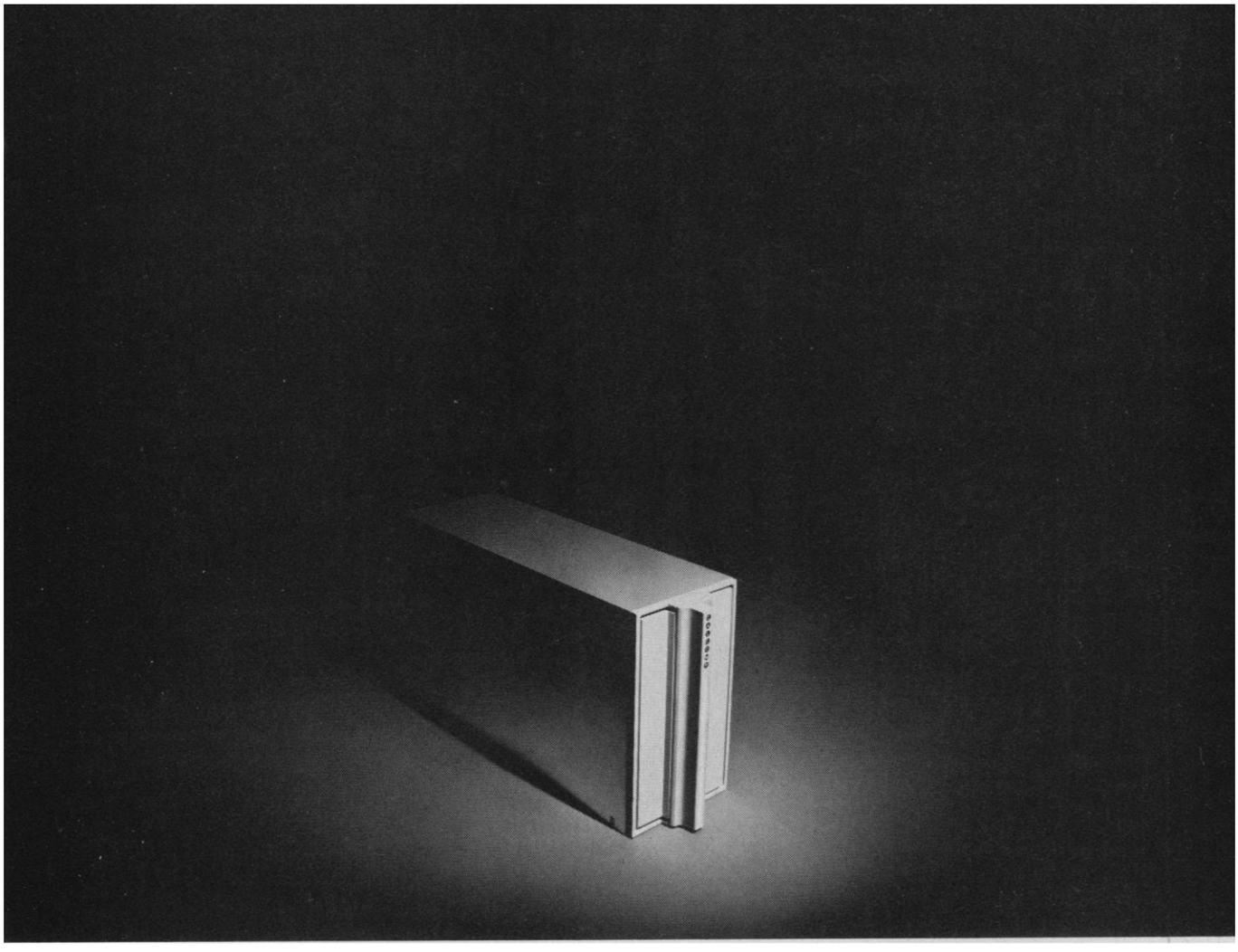

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LETTERS

Construction of Human Tumor Viruses?

A by-product of experiments that have already been conducted in several laboratories may be new viruses capable of producing malignant diseases in humans. Our concern has been initiated by a description of the work of S. S. Kalter and his colleagues (*1*). It appears that an extract derived from the cocultivation of cells containing a murine sarcoma virus and cells persistently infected with a baboon type C RNA virus is capable of producing tumors in dogs, marmosets, monkeys, and chimpanzees. Neither the murine virus (a mouse virus with an exceptional efficiency for inducing "malignant transformation" in culture) nor the baboon virus alone is capable of causing tumors in these animals. The production of malignant tumors in such a variety of primate species suggests the possibility of creating viruses that are oncogenic for humans. Given the perilous consequences, we see no compensating scientific justification for these experiments.

We recognize that at present there is no conclusive evidence for a viral causation of any human malignancy. However, it has been clearly demonstrated in all animal species so far examined that viruses manufactured in the laboratory can be oncogenic. It seems only reasonable to assume that humans may be similarly affected. Indeed, it is important to make sure that current experiments do not prove this assumption to be correct.

Informed officials at the National Cancer Institute have stated that the above experiments were carried out in appropriate facilities. We ask whether any facility is adequate to meet the possibility, even if remote, of containing an artificially created virus that is potentially a human tumor virus.

Concern has been expressed in the scientific community about the safety of the construction of DNA's involving bacterial plasmids and segments of mammalian genomes. In this case, the danger rests on the possibility of inadvertently picking up and amplifying unwanted genetic information that might alter in some way the natural bacterial flora in man and somehow be transmitted into human cells. We believe that the biohazards resulting from such bacterial cloning experiments are minimal when compared to the apparent success in selecting for oncogenic viruses capable of producing tumors in a wide spectrum of primates. Therefore, we urge that all experiments involving cocultivation of known oncogenic viruses with primate viruses be immediately halted until the safety of such experiments are extensively evaluated.

LAWRENCE A. LOEB
KENNETH D. TARTOF
Institute for Cancer Research, 7701 Burholme Avenue, Fox Chase, Philadelphia, Pennsylvania 19111

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1. H. M. Schmeck, Jr., *New York Times*, 28 May 1976, p. A14.

Government Talk

I always enjoy Philip H. Abelson's editorials, but "More laws, more complexity" (25 June, p. 1291) was a highlight. Abelson opens by quoting the inscription on the front of the National Archives building, "What is past is prologue." I add the story of the Washington cabbie who was asked by his tourist passenger what that meant. He answered, "Lady, that's government talk for 'You ain't seen nothin yet!' "

So true. And so government of the people, by the lawyers, for the lawyers progresses to the end, described by T. S. Eliot as coming "not with a bang but a whimper."

W. GRIERSON
Agricultural Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, Post Office Box 1088, Lake Alfred 33850

The Ames Assay

The issues raised by Gina Bari Kolata (News and Comment, 18 June, p. 1215), Harry Rubin and Bruce N. Ames (Letters, 23 Jan., p. 241), and Bridges (*1*) with respect to the use of microbial mutagenesis assays for detection of chemical carcinogens invite further discussion. There is no question that the measurement of backmutation frequencies in certain bacterial strains has value as a component of testing programs seeking to identify substances potentially harmful to humans. What can be seriously questioned is the implication that either a frameshift or base-pair substitution mutation in a haploid prokaryote has any equivalency with the multistep, multifactorial process of carcinogenesis in eukaryotic organisms.

As one justification for the use of the microbial assay for chemical carcinogen identification, Ames claims that "carcinogenicity and mutagenicity results for the polycyclic hydrocarbons show an excellent correlation," although it is not clear whether this correlation is qualitative or quantitative, or both. While many carcinogens show some degree of mutagenic activity in various test systems, even a cursory examination of the quantitative experimental data does not support the proposed correlation (Table 1). A large number of studies subsequent to Iball's (*2*) have provided ample support for his ranking of aromatic hydrocarbon carcinogenicity.

Moreover, if a group of direct-acting agents, which should not be influenced by the vagaries of metabolic activation, are similarly considered, the absence of a correlation is again evident (Table 2).

Over and above the difficulties presented by this lack of correlation between microbial mutagenicity and rodent carcinogenicity results is the conceptual problem in the overly simplified view of cancer induction as resulting from a point mutation. While there is very likely a genetic component in the collection of diseases subsumed by the designation cancer (*3*), the progressive and evolving nature of these diseases in humans, as well as in laboratory animals, appears to be the factor of critical importance. Although many chemical carcinogens may exhibit mutagenic activity in certain assay procedures, the mutational origin of cancers remains an unproven hypothesis, with a substantial body of evidence in support of other mechanisms (*4*).

Finally, there is the matter of perspective with respect to the design of experiments. The salmonella strains widely used for mutagenesis assays at the present time have been constructed by genetic manipulation with the specific goal of showing that chemicals that are carcinogenic in various mammalian test systems will be mutagenic in these bacteria. The conscious selection of those strains whose response supports a preconceived notion is self-fulfilling and not a true test of correlation of the mutagenic and carcinogenic action of chemicals. While one can share the social concerns of most investigators with respect to the potential human risk from exposure to chemicals in the environment, the means to identify agents which exhibit biological activity (mutagenesis, carcinogenesis) and to establish mechanistic relationships must remain unbiased. In a *Science* editorial (30 Jan., p. 341), Alvin M. Weinberg considers the problem of working at the interface between the laboratory and the public arena, and his cautions regarding the carry-over to scientific analysis of the less rigorous standards of validation acceptable in public forums are worthy of reflection.

Table 1. Carcinogenicity (Iball's index) (*5*) and mutagenicity (revertants per nanomole) (*6*) of polycyclic aromatic hydrocarbons. Marginal activity is indicated by ±.

Chemical	Carcinogenicity	Mutagenicity
7,12-Dimethylbenz[*a*]anthracene	151	19
3-Methylcholanthrene	80	58
Benzo[*a*]pyrene	75	121
Dibenz[*a*,*h*]anthracene	26	11
Benz[*a*]anthracene	±	11
Dibenz[*a*,*c*]anthracene	±	175
Chrysene	±	38
Benzo[*e*]pyrene	0	0.6

Table 2. Carcinogenicity (percentage of mice with tumors) and mutagenicity (revertants per nanomole) (*6*) of direct-acting agents.

Chemical	Dose (mg)*	Carcinogenicity	Mutagenicity
Dimethylcarbamoyl chloride	5.0	70	0.04
β-Propiolactone	0.73	60	4.1
Proprane sultone	0.3	42	6.6
Diepoxybutane	1.1	17	
	0.1	14	0.12
Glycidaldehyde	3.3	24	
	0.1	6	19

*Subcutaneous injection in mice once weekly (*7*).

The Ames assay will continue to be useful as one of a battery of first-step prescreens for chemical agents that may have the potential for interacting with cellular genomes. However, the implication that positive results in this microbial mutagenesis system will correspond to carcinogenicity in experimental animals or in humans does not appear, at present, to be substantiated.

ANDREW SIVAK

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Athey implies that we can rely on failure brought about by the lack of genuine learning in the "real" world, after college, to motivate students to work honestly at earning their degrees. Unfortunately this does not square with what cheaters perceive are the rewards to be gained from cheating, nor with the experiences we all have had of seeing both the ignorant and the unethical go on to attain quite considerable success.

In any event, let's not wait for future employers (or "life") to teach our students an ethics lesson; it is part of our responsibility. So let's do our share, recognizing that it is regrettably much easier said than done.

AMITAI ETZIONI
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Center for Policy Research, Inc., 475 Riverside Drive, New York 10027

Understanding Mathematical Proofs: Conceptual Barriers

The article by Gina Bari Kolata "Mathematical proofs: The genesis of reasonable doubt" (Research News, 4 June, p. 989) is in some respects misleading. Since it has already inspired a *New York Times* editorial on the so-called "Crisis in mathematics" (*1*), a reply seems warranted. Has mathematics in fact become so complex that proofs are often too long and involved to be properly understood by human beings?

The specific case alluded to—recent work in "homotopy theory" by E. Thomas and R. Zahler—can be dismissed. Like other scientists, mathematicians sometimes make errors and disagree; the issue in question has now been resolved (in favor of Thomas and Zahler) (Letters, 9 July, p. 98), and the amount of time required was not especially long.

Long proofs are hardly an innovation in mathematics. It is easy to find examples from the 19th century. In mathematical astronomy, Delaunay's theory of the moon's motion contained many enormous equations (some fill whole folio pages). It used to be said that one could check such an equation by measuring it—if over 18 inches long, it must be wrong. Shanks spent years calculating pi to 707 decimal places; after the advent of computers it was found that his last 200 digits were wrong.

But the intellectual barriers to be surmounted are more often conceptual than computational. Hawkins (*2*) has written an enlightening account of the struggles of some very distinguished 19th-century mathematicians with the "easy" concepts of continuity and differentiability. There were quite a few blunders. Extremely bright people went astray, not because the proofs were excessively long, but because, even though the concepts were correctly defined on a formal or verbal level, their ramifications were not yet understood on an intuitive level. The "standard" examples and counterexamples with which we now stimulate and guide our imaginations had yet to be discovered. One hundred years later these concepts and theorems cause no trouble at all; they form part of every course in advanced calculus.

Perhaps the most famous "monster proof" in recent mathematics is the theorem of Feit and Thompson (*3*), which settled a fundamental problem about the structure of finite groups. Their proof fills an entire issue of a journal. Yet this work has been assimilated without intellectual indigestion; on the contrary, the new ideas and techniques it introduced have caused group theory to flourish.

The point is simply this: a human mathematician does not attain an understanding of a proof merely by checking that all the individual steps have been strung together according to the rules. On the contrary, such detailed mechanical plodding is neither necessary nor sufficient. What is crucial is to see through the technicalities to grasp the underlying ideas and intuitions, which often can be expressed concisely and even pictorially. Once the gestalt is perceived, the competent technician can fill in as much formal detail as needed. Jacob Bronowski (*4*), speaking of the work of John von Neumann, has put it most beautifully: "What is running through the page is a clear intellectual line like a tune, and all the heavy weight of equations is simply the orchestration down in the bass."

PAUL R. CHERNOFF
Department of Mathematics, University of California, Berkeley 94720

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1. *New York Times*, 2 June 1976, p. A34.
2. T. Hawkins, *Lebesgue's Theory of Integration: Its Origins and Development* (Univ. of Wisconsin Press, Madison, 1970).
3. W. Feit and J. Thompson, *Proc. Natl. Acad. Sci. U.S.A.* **48**, 968 (1962); *Pac. J. Math.* **13**, 775 (1963).
4. J. Bronowski, *The Ascent of Man* (Little, Brown, Boston, 1973), p. 433.

Erratum: In the letter "Kepone chronology" by Rudolph J. Jaeger (9 July, p. 94, column 3, paragraph 3, line 9), the airborne Kepone concentration in the Life Science Products plant measured by state of Virginia officials in July 1975 was erroneously given as 3 mg/cm^3. The correct concentration was 3 mg/m^3. A portion of a sentence in the preceding paragraph was also erroneously omitted (line 14). The sentence should have read, "A chronicity factor, calculated from these data, is the ratio of the single LD_{50} value *divided by the* LD_{50} *value* in repeatedly dosed animals."

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23 July 1976, Volume 193, Number 4250 **SCIENCE**

Glamorous Nuclear Fusion

Viewed from a distance, energy from the fusion of light nuclei is a glamorous concept. Advocates have talked of obtaining unlimited amounts of cheap, clean energy from the virtually inexhaustible deuterium of the oceans. But looked at closely, deuterium fusion is far from practical application; if achieved it will be costly, and it will create large quantities of radioactive substances.

The radioactivity associated with fusion arises when neutrons produced by the reaction of deuterium with deuterium or tritium collide with wall and structural materials. In the generation of a given amount of energy considerably more neutrons are produced by fusion than by fission. This is true whether the fusion occurs in a magnetically confined plasma or is induced by lasers. Thus, shortly after a fusion device begins to generate energy in substantial amounts, the inner walls will become so radioactive as to prevent direct contact by workmen. With more lengthy exposures a radioactive waste disposal problem will ensue.

Neutrons undergo many nuclear collisions before they are absorbed. These encounters damage the crystalline structure of solids. In a practical fusion device each atom of the containing inner wall would be drastically displaced many times a year. Moreover, the very fast neutrons from deuterium-tritium reactions create hydrogen and helium within lattice structures, leading to embrittlement. These damaging radiation effects would be likely to necessitate replacement of highly radioactive materials, requiring the use of complicated remotely controlled equipment.

To obtain a useful rate of fusion in the easiest case—deuterium plus tritium—energies of 10 kiloelectron volts, corresponding to 100,000,000°C, are required. The fusion device that is currently receiving most funding is the tokamak. This machine employs magnetic confinement to keep the hot plasma away from metal walls. To achieve production of practical amounts of energy, a very large volume of plasma and a correspondingly large magnetic field are required. But more than just any large magnetic field is needed and the problems of confining plasma of a useful density may never be solved. During the past 20 years, some of the world's most talented physicists have worked toward practical fusion. The outstanding lesson that they have learned is that hot plasmas are difficult to confine.

The U.S. contingent in fusion research has been supported with a total of about $800 million. Thus far the results, though moderately encouraging, are not impressive—to produce an output of 1 watt of fusion power requires an input of about 10^6 watts. To reach a break-even condition will apparently require building a succession of very large, very costly devices employing superconducting coils. The total cost of attaining a 10-megawatt output by a fusion unit in 1990 has been estimated to be $10 billion. This is in contrast to a cost of $100 million to reach the same energy output by a solar device or a breeder reactor.

Moreover, the tokamak device does not produce power continuously but must go through a cycle during which output falls to zero. Utility executives have enough headaches without trying to cope with that kind of source of power.

Nuclear fusion has been hailed as one of the world's three major long-term energy options along with breeders and solar energy. Ultimately, its great potential may be harnessed and this nation should continue to support efforts to reach the goal. However, thus far fusion has been like a pot of gold at the end of a rainbow. The beauty of the rainbow should not dazzle us into depending on riches we may never see. Nor should the glamor of the challenges of the high technology of fusion be allowed to keep attention away from such humdrum measures as conservation and the development of a practical photosynthetic energy source.—PHILIP H. ABELSON

This editorial is based largely on material that has appeared in *Science*, especially the articles by W. D. Metz in the issues of 25 June and 2 July.

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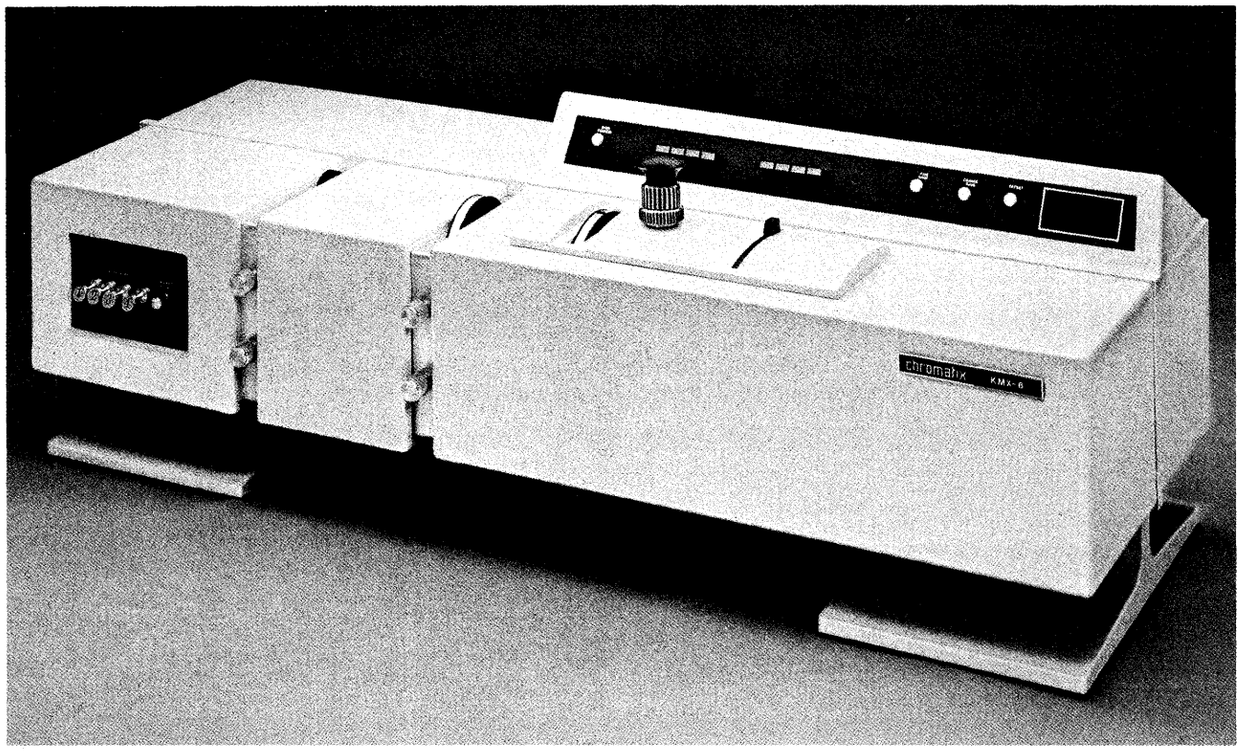

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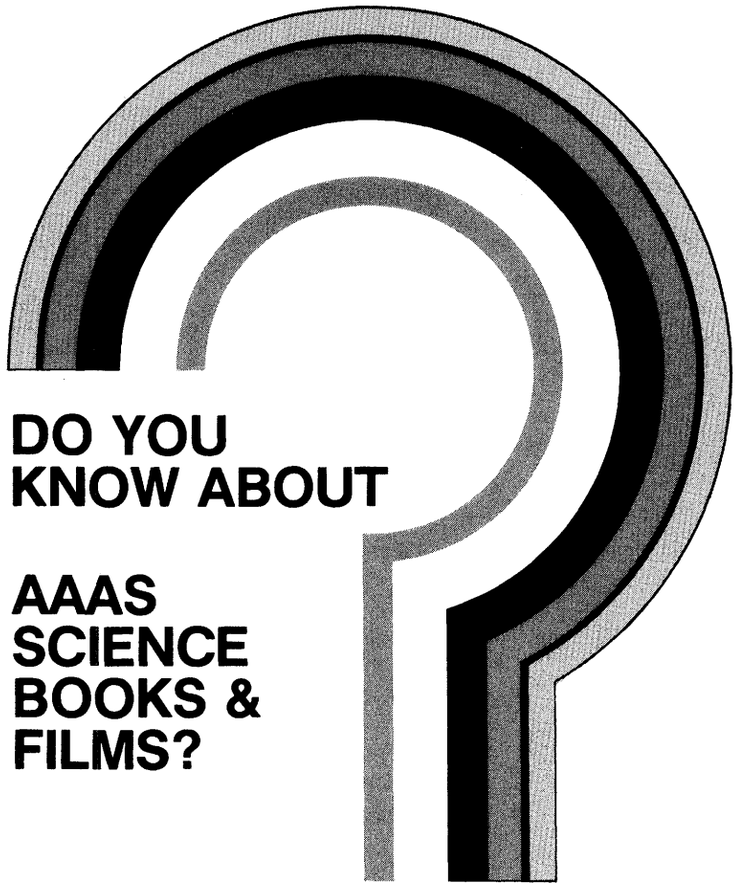

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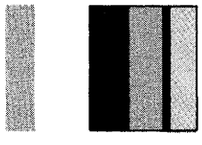

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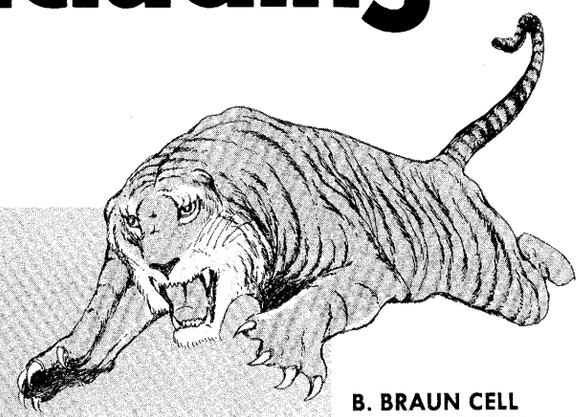

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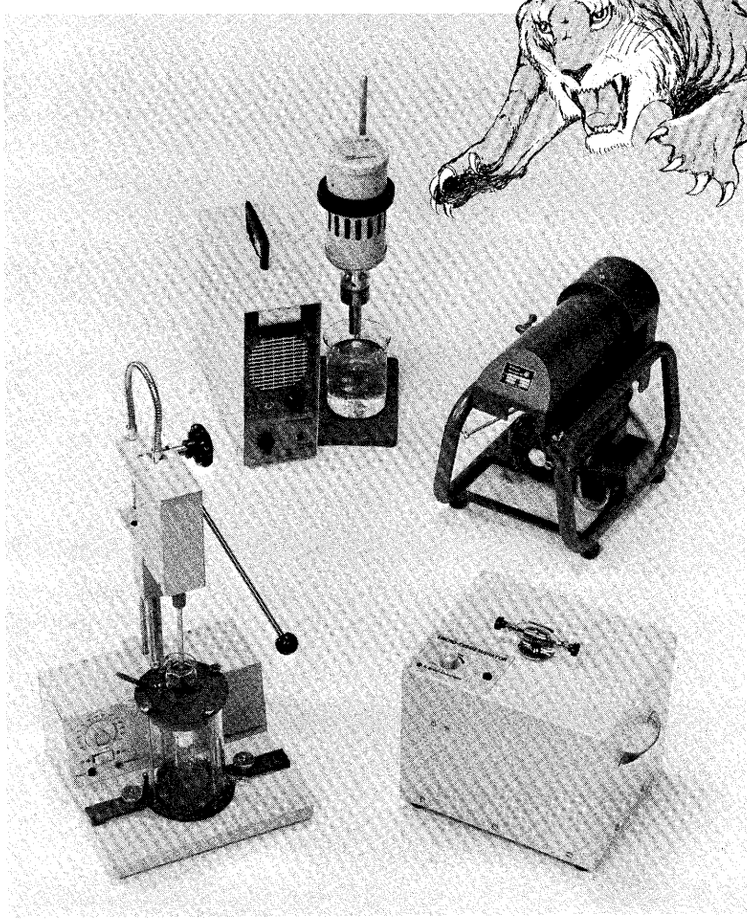

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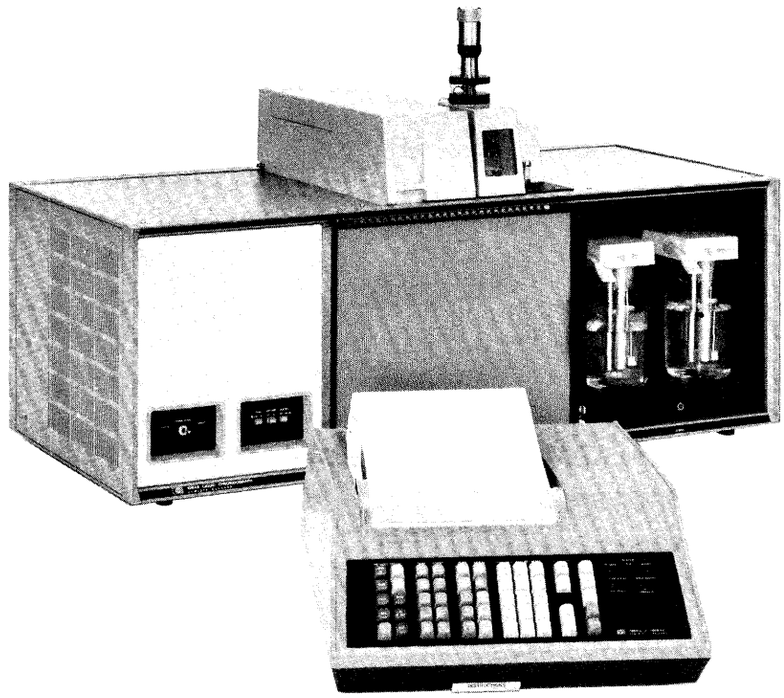

It's often said that the current state of the art in liquid chromatography is comparable to that of gas chromatography 10 years ago. The gap has been narrowed appreciably by the introduction of Hewlett-Packard's 1080 Series High Performance Liquid Chromatographs which combine significant advances in LC techniques with the latest in microcomputer technology to yield a new level of performance and ease of operation.

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The variable volume injector remains in the solvent flow path at all times except when it is loading a sample. This constant flushing ensures sample-to-sample cleanliness. It consumes only the amount of sample actually injected and injects at full column pressure without flow interruption.

A single wavelength UV detector with excellent sensitivity, noise, and drift characteristics is standard. Other detectors may also be connected.

The unifying element for the entire 1080 is the digital microprocessor which interprets your instructions, issues the necessary internal commands to the various parts of the instrument, monitors and controls performance, integrates the chromatogram (and it's a very sophisticated integrator) and calculates the final report. It also checks that all parts of the instrument are operating properly. A vapor sensor in the column compartment, keyboard-settable upper and lower pressure limits and temperature limits, waste reservoir level sensors, and visual and audible alarm signals with automatic corrective action where appropriate, all contribute to safe operation.

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IN THIS ISSUE

Summer 1976

Elaborate Drug Control Set for Montreal Olympics

The most elaborate drug control program in the history of the Olympic Games will be carried out in Montreal, Canada, for the XXI Olympiad this July. A complete drug-detection laboratory using 12 Hewlett-Packard gas chromatographs, two laboratory automation systems and two computerized gas chromatograph/mass spectrometer systems stands ready to monitor the 12,000 athletes from 131 countries who will compete in the Olympics. Half of this analytical instrumentation is on loan from Hewlett-Packard for the duration of the games. This facility will ensure that athletic competitions are based on the natural abilities of the participants and not on the unfair advantages drugs offer.

The use of drugs by athletes was a growing problem until recently. It probably reached its peak during the 1960's, when an estimated 35 percent of the participants at international events used some form of chemical stimulant. The 1968 Winter Olympiad at Grenoble, France, saw the first small-scale drug testing of athletes. It paid off. At the 1972 Olympics in Munich only 12 of the 2049 samples tested contained banned drugs. The expanded drug control program for this year's Olympics will be even more sophisticated.

"Although we will follow the same concept of mass screening for drugs first used in Munich, our program reflects recent advances in instrument technology and methods of chemical analysis," said Dr. Robert Dugal, head of the drug analysis laboratory at the Institut National de la Recherche Scientifique (Santé) (INRS) of the University of Quebec.

"Since the INRS laboratory was selected by the International Olympic Committee (IOC) to carry out the program during the Montreal games, our prime concern has been to develop a sensitive, completely accurate and fast system," said Dr. Dugal. "In order to process nearly 3000 urine samples in the brief time allotted to us, we have undertaken to automate and computerize all chromatographic operations."

Two minicomputer-based HP 3352B laboratory automation systems convert the output signals of the gas chromatographs into finished analytical reports.

"Automatic data acquisition is an important aspect of the process," said Dr. Dugal. "The system has the advantage of eliminating human error although it cannot speed up the process due to the very nature of gas chromatography."

The 3352B data system is programmed to recognize the nearly 200 types of drugs banned by the IOC. "For the first time during the Olympics we will be using newly developed GC/MS methods to look for the anabolic steroids," said Dr. Dugal.

These drugs, which strengthen muscle tissue, must be taken for extended time periods to be effective. However, their effectiveness is diminished if athletes must interrupt their use for some time before being able to pass doping controls. The program is hoped to act as a deterrent against the misuse of steroids which has increased in recent years while the use of easily detectable drugs like amphetamines has decreased considerably.

GC/Mass spectrometers provide positive identification of suspected drugs.

After every Olympic event the laboratory receives urine samples from the top four finishers and from other competitors picked at random. When the data system recognizes the possible presence of a banned drug, the sample is run on one of the two GC/MS systems for positive identification. It is estimated that about ten percent of all samples reach this stage. The unusually high number does not necessarily reflect a high rate of banned drugs in samples, but is due to the presence of nicotine whose peak may hide prohibited drugs.

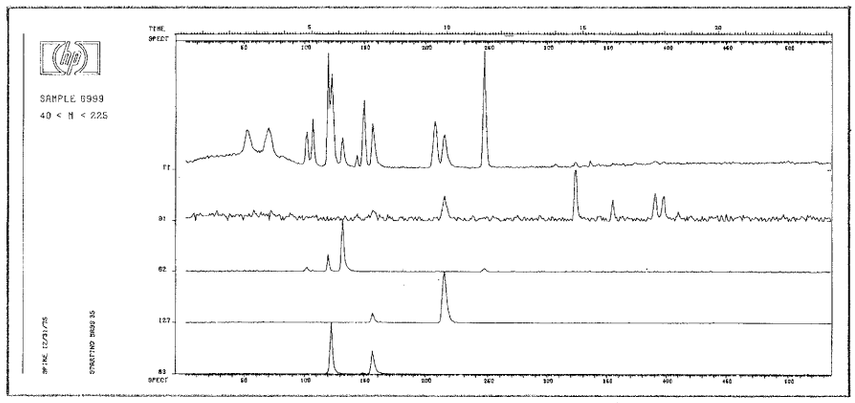
The INRS laboratory has been preparing for the Olympic events for over two years during which many excretion and metabolism studies on prohibited drugs and steroids have been completed to supplement existing information.

"Actual biological samples, obtained from individuals known to have taken the drugs, were processed to give us actual qualitative and quantitative results," said Dr. Michel Bertrand, deputy director of the doping control program for the Olympics. "The research data are stored in the systems' data libraries and will be used as reference in the identification of actual drug traces in samples. Acquisition of that data was an essential part of our preparation to computerize our mass screening operation.

"As new drugs become available, there may be a temptation to use them in the hope of defeating the present drug-detection methods. But at the same time, detection methods are continuing to improve rapidly, both in sensitivity and specificity and thus attempts to circumvent our controls are not likely to succeed."

Modern analytical techniques and instrumentation will ensure drug-free competition at the XXI Olympiad.

A Sensitive Versatile Tool For The Analysis Of Organic Compounds In Environmental And Biological Systems



This chromatogram plot from GC/MS analysis of a water sample helps identify trace amounts of volatile organic compounds. Peaks in the single-ion chromatograms (the four lower lines) indicate where certain classes of compounds may be found in the corresponding total-ion chromatogram (upper line). On command, the data system recalls the appropriate spectrum from computer memory, compares it with reference spectra in its disc library, and identifies the compound with a stated probability of match.

Ultrasensitive measurement and identification of organic compounds can be accomplished by combining gas chromatography and mass spectroscopy. The Trace Organics Laboratory at the Foremost Foods Company Research Center, Dublin, California, a major food industry laboratory, is centered around a Hewlett-Packard 5981A Gas Chromatograph/Mass Spectrometer (GC/MS) and an HP 5933A Data System for the analysis of organic compounds in drinking water, food, and biochemical systems.

Using a Hewlett-Packard GC/MS and data system, Foremost Foods' research lab can solve challenging problems for scientists within the company and for a variety of clients in its contract research services function. Analyses range in scope from the part-per-trillion identification of volatile organic compounds in drinking water to the identification of sterols in the lipids of antarctic krill.

New concern about environmental pollution has centered on a huge number of organic chemicals—for example the halogenated hydrocarbons such as chloroform that the Environmental Protection Agency has recently identified in drinking waters. Careful analyses have revealed several hundred other trace compounds in the part-per-billion and part-per-trillion ranges, and have focused attention on analytical techniques capable of identifying and quantifying trace amounts of these compounds. Effective analysis demands a versatile analytical tool that can provide both qualitative and quantitative answers, and data must be reproducible and easily managed to provide ready access and archival documentation.

Specialized analysis of volatile organics from aqueous media at the Foremost laboratory has been easily adapted to the HP 5981A GC/MS and the HP 5830 series gas chromatograph. The method involves "scrubbing" volatile organics from a water sample using a stream of helium in a special chamber. The gas stream is then passed through a small chromatographic column filled with a porous polymer material that traps the volatiles. Once "absorbed" in the trap, the volatiles are "desorbed" into the GC/MS for analysis.

Foremost's research group selected the HP system for its overall flexibility, citing in particular HP's extremely powerful software which provides impressive flexibility in data management and storage for a large number of in-house projects and contract clients. The libraries of reference mass spectra of chemical compounds that are available with the system, plus those accessible by using the data system as a time share system, allow the group to search approximately 100,000 spectra to find suitable matches.

More information about the Hewlett-Packard GC/MS system is yours for the asking. Just check GC/MS/Data System on the reply card.

Hewlett-Packard GC/MS data system serves in-house and contract research functions at Foremost Foods.

A Better Way to Use O-Rings

If you use glass columns in your gas chromatograph you probably install them with silicone rubber O-rings. Traditionally, two or three O-rings are backed up with a reversed Swagelok back ferrule (Figure 1). Recently we have had very good results using a single O-ring and a reversed front ferrule (Figure 2).

Tightening the nut finger-tight produces a very reliable seal, probably because the longer ferrule does a better job of confining the O-ring to the sealing area. At the same time, columns are easier to remove because there is less rubber to stick to the fittings.

This mounting method has been used successfully for programmed runs up to 260°C. However for high temperature work (above 250°C) Vespel® or graphite seals are more satisfactory.

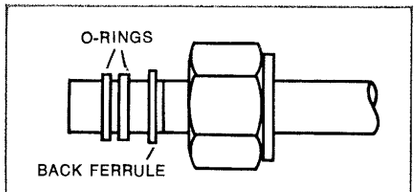


Figure 1
Common configuration for column installation.

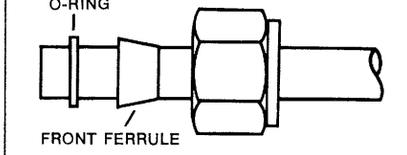


Figure 2
New configuration.

Reducing Data: A Case Study

What is the best way? It is probably not the way you select for the first trial run on a new analysis. Even with all of the instrumental parameters optimized there remains the question of how to convert the raw data to the most informative answers. This often requires performing multiple trials, each with a slightly modified set of data reduction parameters.

We have available a study of a different approach using the 3354A Laboratory Automation System. In this system all of the raw instrument readings are stored on the disc exactly as they are received, prior to any calculations. The raw data file contains a complete electronic image of the analysis and may be re-analyzed as often as desired. The experimental variation inherent in multiple runs is totally eliminated.

In this study the data reduction was performed using LAB BASIC II programs which read data from a raw data file. A thorough examination of the effects of changes in the computation scheme lead to a much better understanding of the significance of both experimental and computational variables. No repeat sample analyses were necessary during this exploration phase. The study includes several chromatograms to illustrate the improvements in analytical accuracy that resulted.

For your copy please check 3354 Lab Automation System on the Reply Card.

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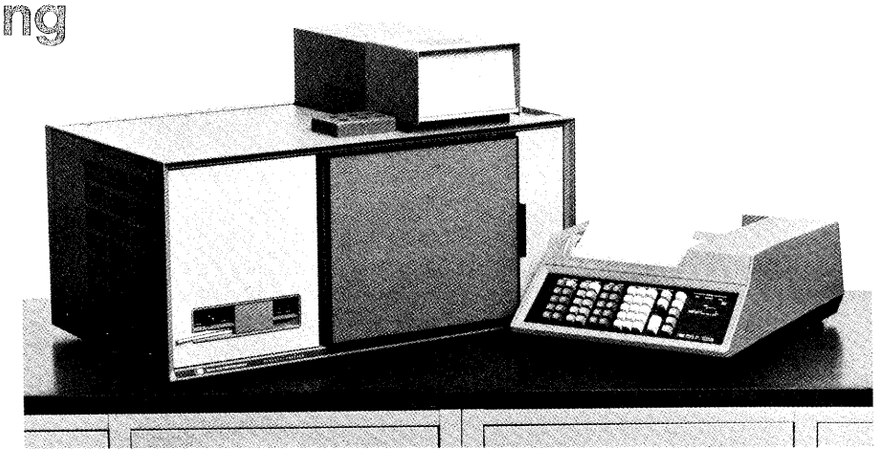

Here's a situation that faces many laboratories today. The sample load is increasing steadily but you just cannot push more samples through your instruments in the time available. After all, if a sample run takes 15 minutes there is no possible way of doing more than 32 in an 8 hour day, even if everything goes perfectly (and it seldom does).

Automatic sample injection is a possible solution. For a rather small investment it can triple the available time on the chromatograph, and by keeping the instrument busy it can approach full utilization of that time. But it just doesn't seem applicable to one of your biggest sample load problems.

This particular sample contains some very high-boilers which must be conditioned out of the column after every 5 or 6 runs. After conditioning it's usually advisable to recalibrate. These necessary interruptions appear to preclude automatic operation.

But not if you're using the Model 5840A Gas Chromatograph. With run programming these formerly manual operations can be included in the automatic cycle. Let's assume that we have 15 samples. We load them in the sampler tray with vials of the calibration standard in positions 6 and 12, then program this sequence:

CHANGE RUN 5 TEMP 1 300
Reset oven temperature to 300°C after the fifth run

CHANGE RUN 5 TIME 30
Wait (at 300°C) for 30 minutes

CHANGE RUN 5 TEMP 1 150
Return the oven to 150°C

When the oven stabilizes, bottle 6 (standard) will be sampled.

CHANGE RUN 6 CALIB 0
Use the data from 6 to calculate new response factors

The second conditioning and recalibration is done with the same commands but using run numbers 11 and 12. Finally we condition again (run number 17, the last bottle) and end the sequence with

CHANGE RUN 17 STOP

Now press START RUN and walk away. When the sequence stops you have 15 reports and the column is ready for more samples. No manual operations were required, no time was wasted.

That's one of the ways the 5840A can help. A few of the others are automatic printing of extra copies of reports, done with run programming, and magnetic card recording of all control parameters, calibration information, and time and run program commands for reuse at a later date. For further information please use the Reply Card.

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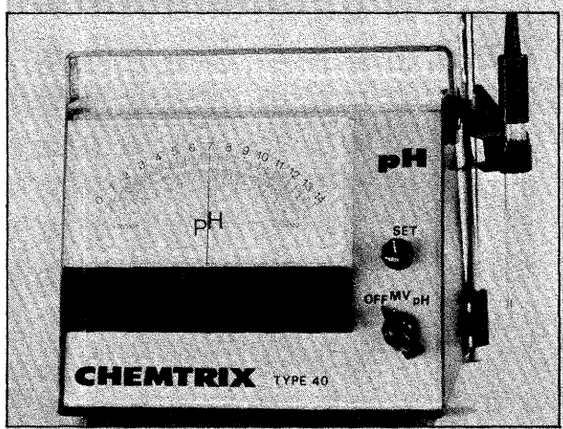

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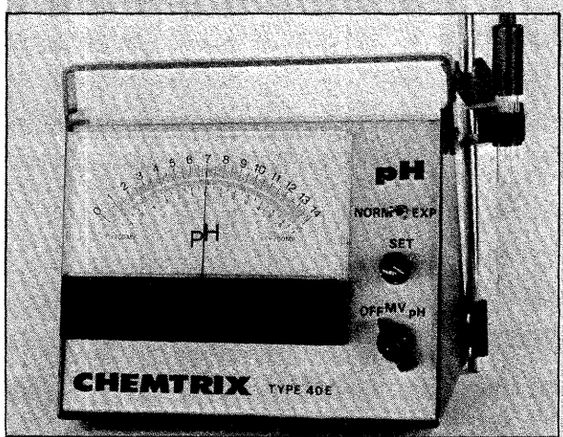

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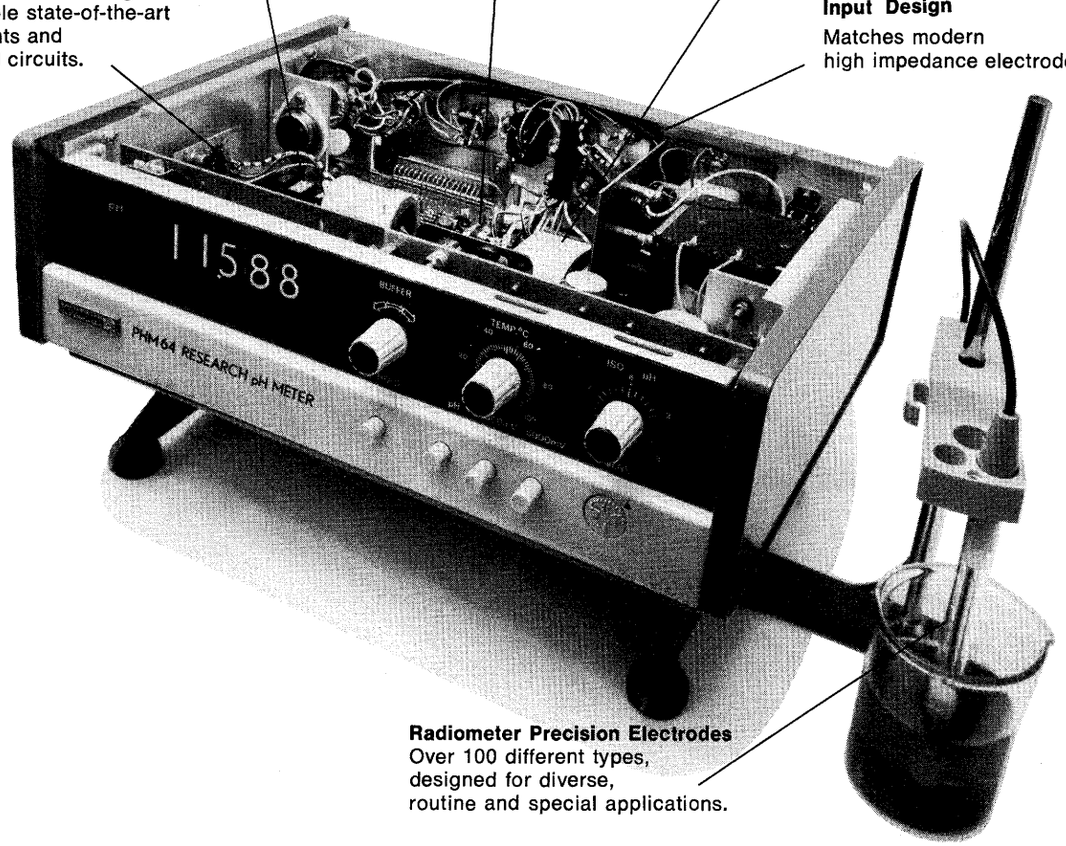

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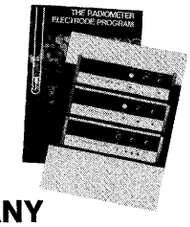

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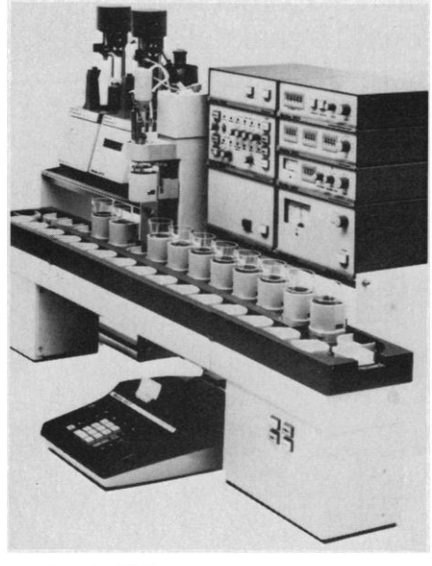

Fig. 1. ST80 sample transport system.

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