10 JUNE 1983 · VOL. 220 · NO. 4602

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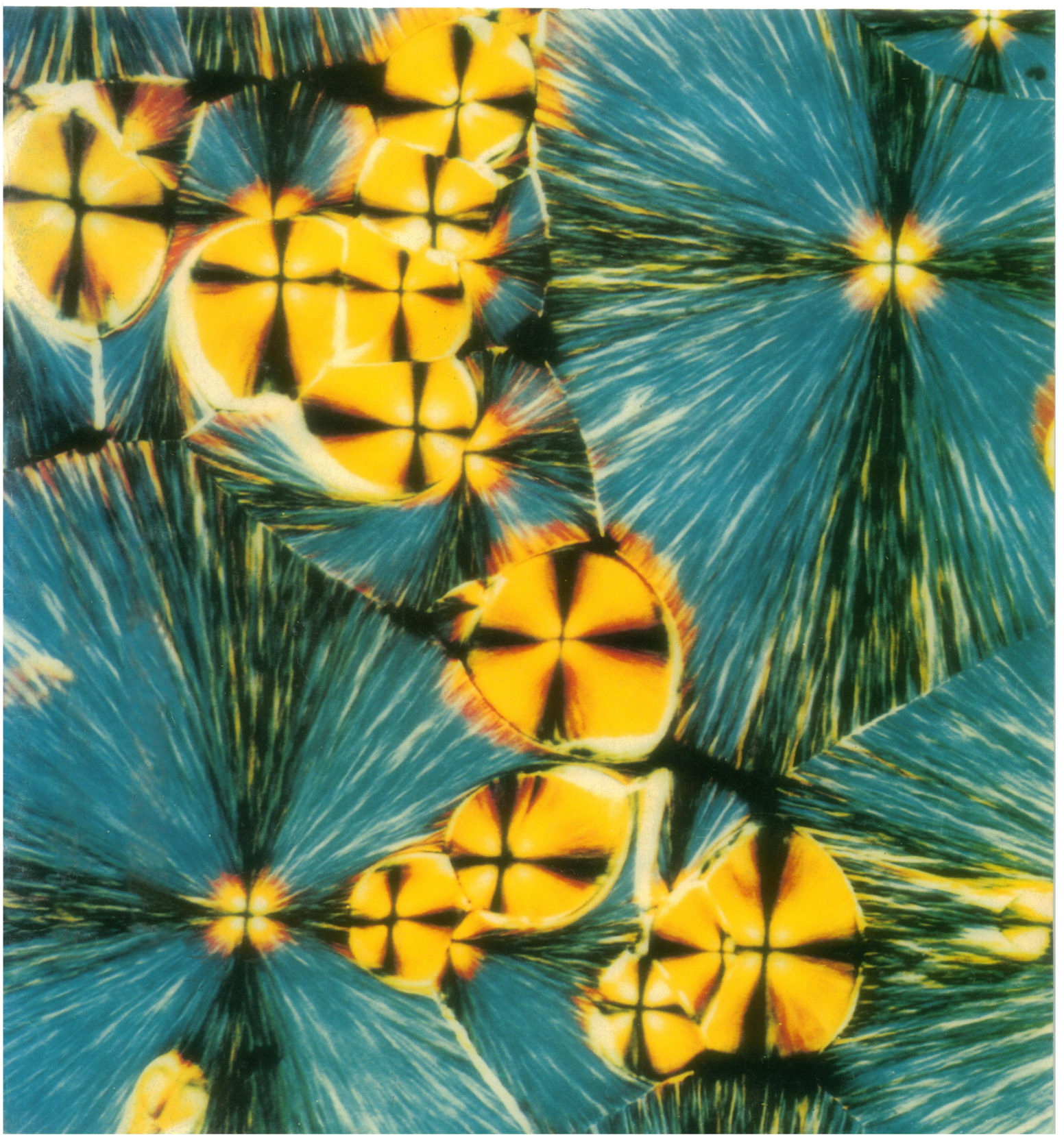

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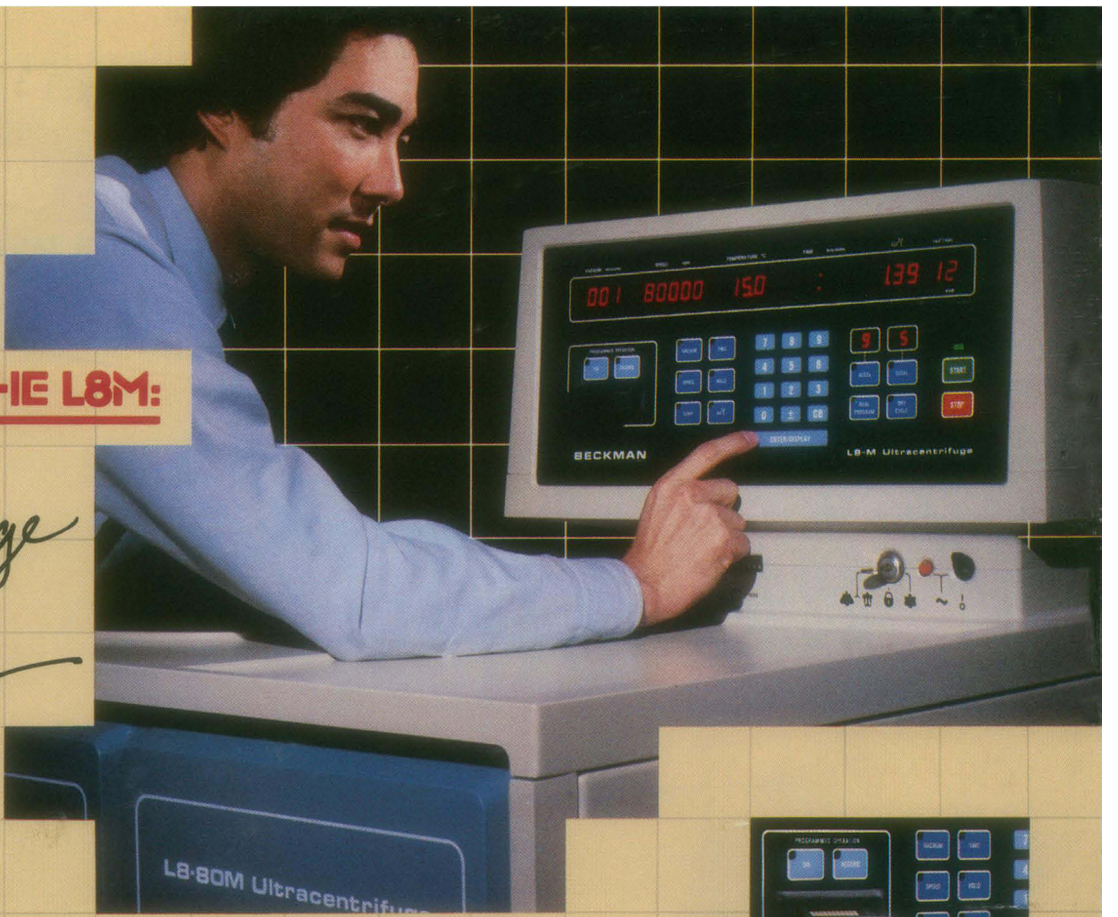

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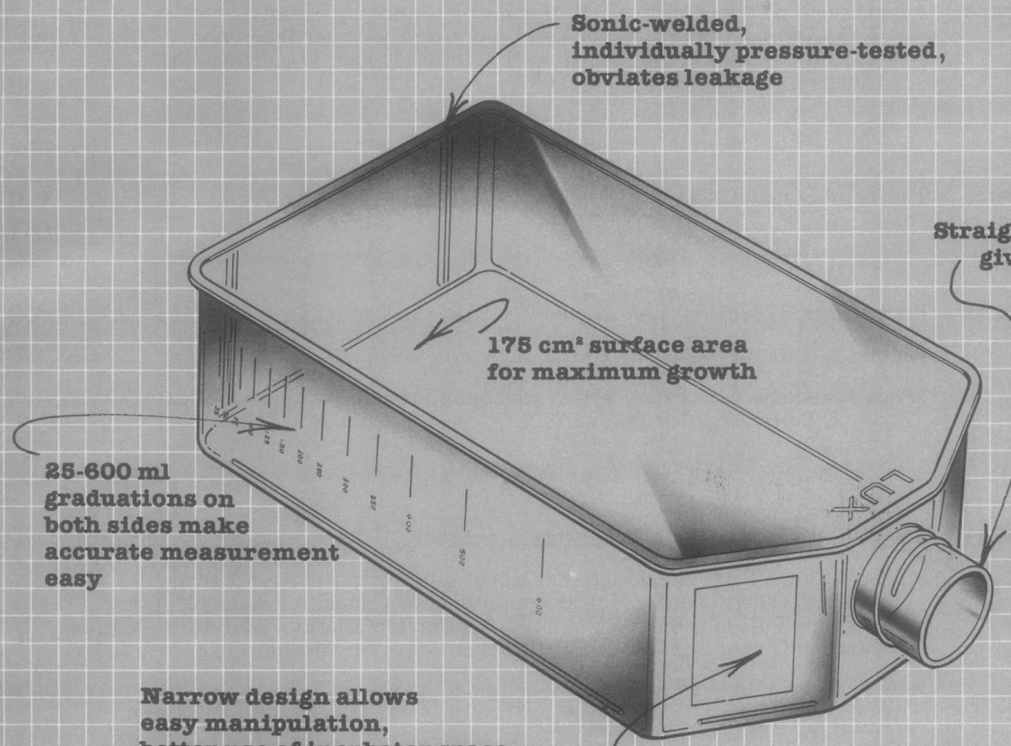

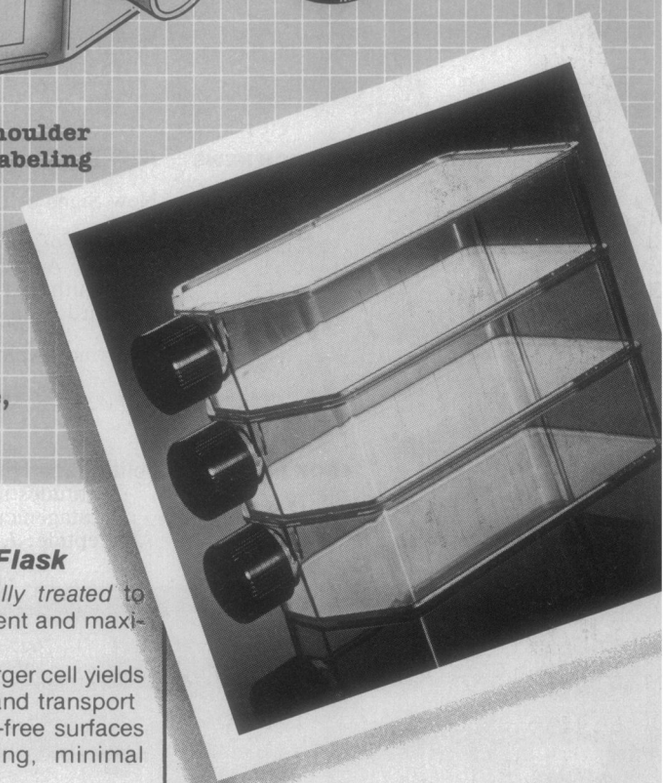

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SCIENCE

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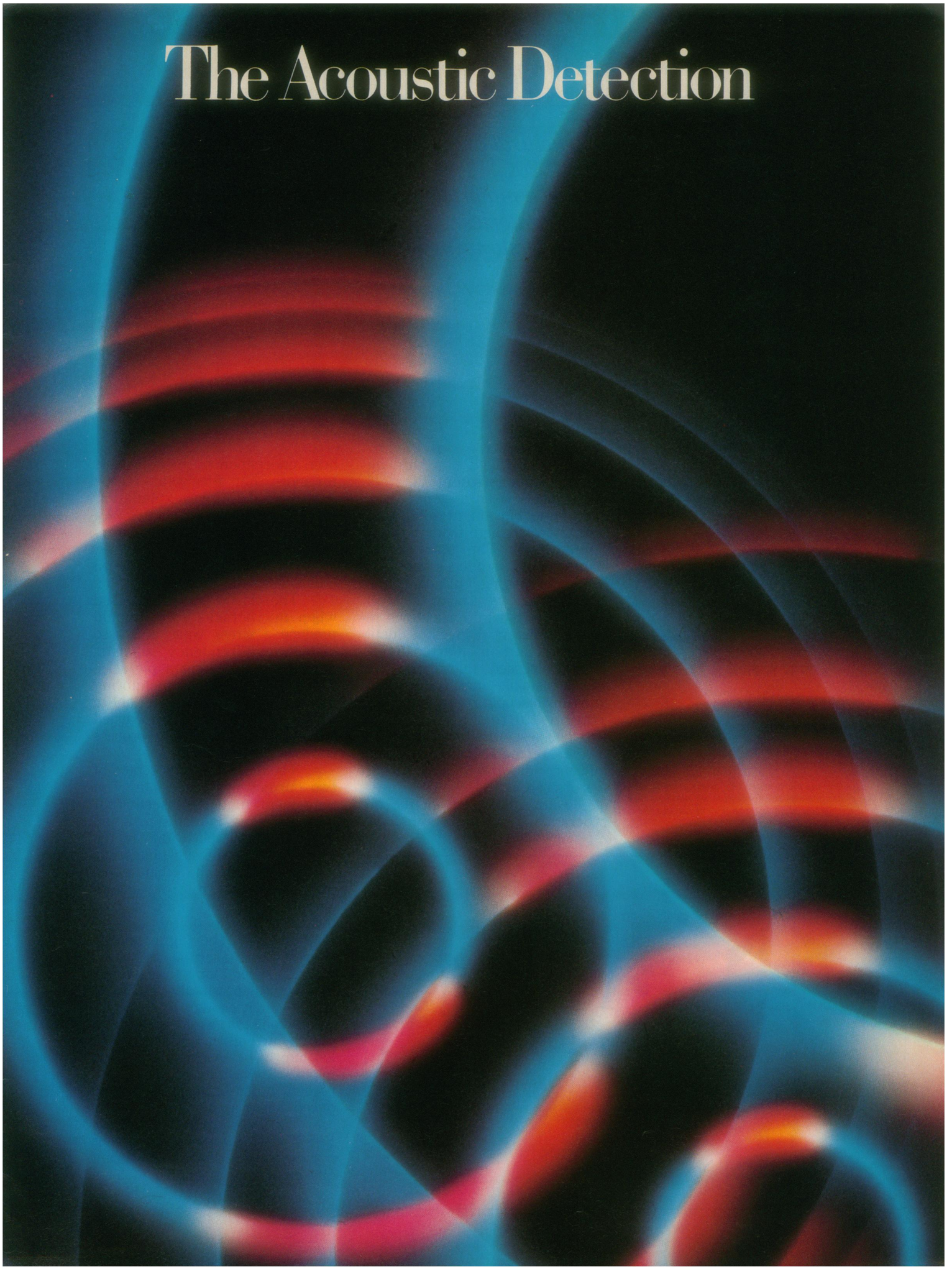
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORTS

COVER

Morphology of the first ferroelectric polymer, poly(vinylidene fluoride), recorded in the polarizing optical microscope at a magnification of about 105 times. The polymer consists of polycrystalline aggregates (called "spherulites"), of which two types are observed in this micrograph. The small, rounded spherulites contain crystals of an electrically polar phase; their large polygonal counterparts are of a nonpolar phase, which can, however, be electrically polarized at high fields. See page 1115. [A. J. Lovinger, Bell Laboratories, Murray Hill, New Jersey 07974]

The Acoustic Detection



The Acoustic Detection

Scientists have studied microstructural discontinuities in high-carbon steel since the early 1920s. By monitoring acoustic emissions, a materials research engineer at the General Motors Research Laboratories has arrived at a more detailed understanding of how one type of discontinuity occurs.

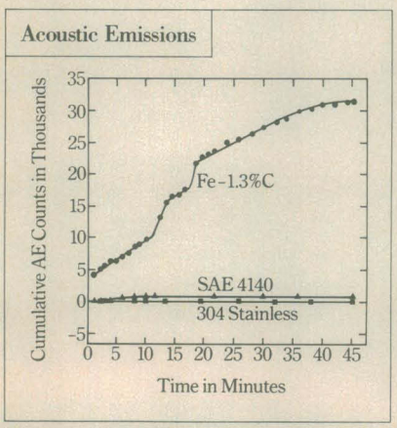
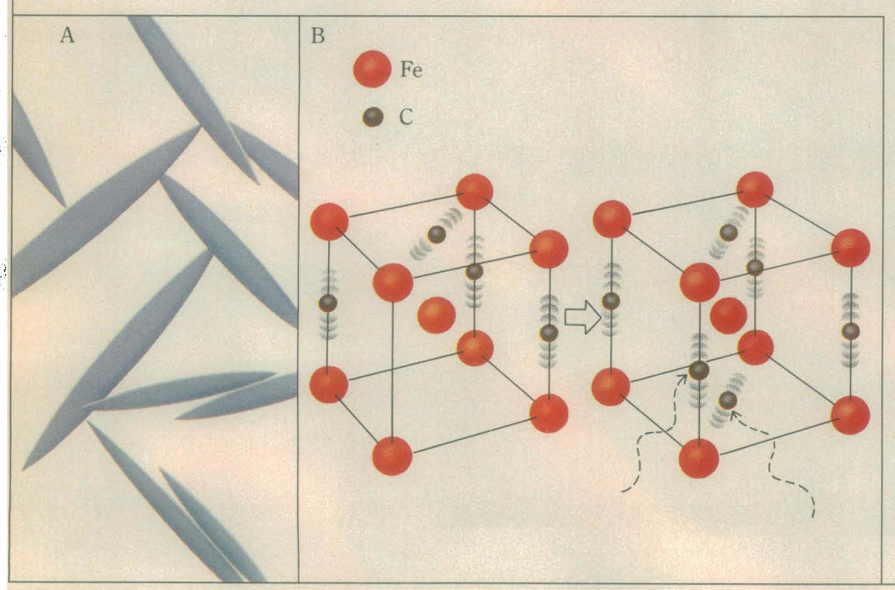


Figure 1: Cumulative acoustic emission counts for Fe-1.3%C steel, and control specimens of SAE 4140 and 304 stainless steel.

Figure 2: Artist's rendering of two proposed sources of microcracking: (A) impingement of the plates during the formation of martensite and (B) carbon atom rearrangement during the aging of martensite.



MARTENSITE is a hard microconstituent of steel which forms when austenite, iron containing carbon in solid solution, is quenched from a high temperature. The martensitic transformation produces steel that is hard and strong, but non-ductile. Through heat treatment, the steel can be tailored to applications requiring different degrees of ductility. High-carbon martensite—a highly stressed microstructure with a plate-like morphology—contains microscopic ruptures or separations 10 to 20 microns in length. These structural discontinuities, termed "microcracks," influence the mechanical properties of steel.

Although aspects of the microcracking phenomenon have been understood by metallurgists for more than fifty years, there is still no definitive explanation for when or how it occurs. An engineer at the General Motors Research Laboratories has devised an experiment that detects the microcracks as they occur.

The elastic energy released when microcracks form should produce a stress wave and associated high-frequency acoustic emission (AE). Using a piezoelectric transducer as the monitoring device, Dr. Michael Shea set out to determine what could be learned about the microcracking process by measuring AE.

The more widely accepted of two current hypotheses—the "impingement model"—asserts that microcracking is transformation-induced, taking place due to the collision of martensite plates during the quench. The other model maintains that microcracking occurs during the aging of martensite after the plates have already formed. The "aging model" suggests that thermal activation enables carbon atoms to rearrange themselves, producing localized stresses high enough to cause microcracking. Dr. Shea's ongoing research into high-carbon martensite led him to believe that the aging hypothesis was important. He proceeded to determine if AE is produced during aging.

For his study, Dr. Shea chose Fe-1.3%C steel, which undergoes martensitic transformation during quenching and is known to form

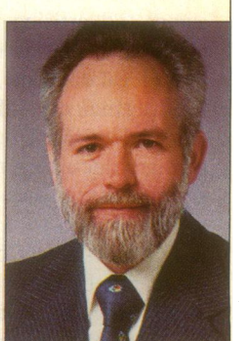
microcracks. To provide baseline data, control specimens of 304 stainless steel and SAE 4140 steel were put through the same procedures as the test composition. When quenched, 304 stainless steel produces no martensite, and SAE 4140 forms a low-carbon martensite which has a lath-type morphology, and generally does not microcrack.

SPECIMENS of the three compositions were quenched to -196°C and then slowly heated to room temperature. Acoustic measurements were made beginning at 0°C, at which point carbon atom mobility is sufficient to allow rearrangement processes to take place, and continued for 45 minutes after the specimens had reached room temperature. No AE was recorded for 304 stainless steel, and only a slight amount for SAE 4140. Significant emission, however, was measured for the Fe-1.3%C steel specimen during the entire testing period (see Figure 1). Since martensite had already formed during the quench, these results support the hypothesis that microcracking is produced during aging of the freshly-formed plates. Dr. Shea ruled out both slip and twinning as sources of AE since the literature indicates that neither factor is significant during aging of martensite below 40°C. The possibility that the AE resulted from isothermal transformation of austenite to martensite could also be excluded because this process does not take place in the composition studied.

"These results demonstrate conclusively," says Dr. Shea, "that microcracking occurs during the aging of high-carbon martensite, thereby providing support for the less accepted of the two models.

"The next challenge," he continues, "will be to quantify the relative contributions of both models—impingement and aging—in an effort to determine which, in fact, is the more important mechanism, thus furthering our understanding of microcrack formation. Then, perhaps, we can more systematically explore ways to minimize microcracking."

THE MAN BEHIND THE WORK



Dr. Michael Shea is a Staff Research Engineer in the Metallurgy Department at the General Motors Research Laboratories.

Dr. Shea received his undergraduate and graduate degrees in metallurgical engineering from Michigan Technological University, and his Ph.D. in materials engineering from Rensselaer Polytechnic Institute. His thesis concerned deformation and fracture of cesium chloride type superlattices. He joined General Motors in 1971.

The areas of metallurgical research pursued by Dr. Shea at General Motors include the mechanical properties of high-carbon steels, mechanically-induced transformation of austenite, and structure/property relationships in nodular cast iron. His exploration of the microcracking phenomenon in martensite was conducted with the help of instrumentation developed by GM colleague Dr. Douglas Harvey.

ter] brings on its Control Data CYBER 205." Later he hints that the European Center may well jump ahead again when they get their next-generation computer. One source is quoted as suggesting that this added computer power "would be to increase the model's resolution."

The "race" for bigger computers should not be simply a matter of increasing model resolution. Using a bigger computer to increase resolution is analagous to using a bigger hammer on a small nail just to drive it in further or faster. Brute force! A better approach might be to redesign the nail in order to better match it to both the wood and the hammer. In the case of NWP, resolution (the hammer) is only part of the problem. Data quantity and quality and model physics (the nails) are equally important. The outcome of the race will depend not only on who has the best computer but on who uses it best.

Kerr implies that the race centers on lengths of usable forecasts and states that the ultimate length is about 10 to 12 days. Most users of weather forecasts would prefer that accuracy be improved on all time scales. Improvements in short-range forecast accuracy are just as important as extending the length of present skill from 6 to 12 days.

Finally, Kerr implies that all improvements in weather forecast accuracy are tied to NWP. Surely NWP is important, but so are making sensible inferences from the numbers, displaying the forecast well, and making good use of the prediction. Without parallel improvements in these less glamorous aspects of weather prediction, the winners of any race for the best NWP may find they are only ahead at the first lap.

ALAN I. WEINSTEIN
Naval Environmental Prediction Research Facility, Department of the Navy, Monterey, California 93940

Metric System in Britain

I hope you will permit a native of the United Kingdom and visitor to your shores to comment on Edward Leete's letter (29 Apr., p. 462) about the lack of use of the metric system in the United Kingdom.

The whole metric system is very firmly established in Britain, but its introduction, as prudence would dictate, involves a long changeover period during which imperial and metric measures coexist. Nevertheless, most prepacked domestic goods are now sold by metric weight (our 2-pound bag of sugar weighs 1 kilogram) and volume (the gallon can actually contain 5 liters); even booze comes in 75-centiliter bottles. Petrol is sold by the liter, and distances are beginning to be given in kilometers.

The clincher is that imperial measurements are simply not taught in school. Within a short time of my 10-year old daughter's first exposure to her American school she confidentially asked me if this "yard" that Americans talked about was something like a meter.

Leete's suggestion that we might be enamored of the mile because of Roger Bannister's athletic achievement a generation ago takes no account of the fact that the British currently have world-ranked athletes who compete at distances of 100, 200, 400, 800, 1500, 5000, and 10,000 meters.

Of course, London still has the Mile End Road, Blackpool its Golden Mile, and if you give someone an inch they're bound to take a yard; but I suppose some things will never change.

DAVID MOORE*
Department of Biology, University of North Carolina, Chapel Hill 27514

*Present address: Department of Botany, Manchester University, Manchester, England M13 9PL.

Organometallic Clusters

So far as I am aware, attempts to prepare practical catalysts by depositing organometallic clusters on supports have been unsuccessful, and the effort could now be likened to an aging, promising young man who keeps on promising for too long. The article by Thomas H. Maugh II (Research News, 6 May, p. 592), reports this sentiment, but it may not be clear that my opinion applies to the preparation of useful catalysts and not to matters of scientific interest. Indeed, I have been involved in a small way in two projects using metal clusters, one in collaboration with D. F. Shriver and the other with J. B. Butt and J. B. Cohen.

ROBERT L. BURWELL, JR.
Ipatieff Laboratory, Department of Chemistry, Northwestern University, Evanston, Illinois 60201

Erratum: In Thomas H. Maugh II's Research News article "New agents active against herpesviruses" (15 Apr., p. 292), Raymond Shinazi was incorrectly reported to have found that 2'-fluoro-5-iodoarabinosylcytosine (FIAC) is "the most potent and effective drug known to date" against herpes encephalitis in mice. Shinazi found that 2'-fluoro-5-methylarabinosyluracil (FMAU) is the most effective drug against this disease.

SCIENCE/SCOPE

Vacuum-tube computers spanning half an acre of floor space will be replaced by modern computers the size of two vending machines when North America's new air defense system goes into operation late this year. Hughes Aircraft Company's Joint Surveillance System will replace aging SAGE (Semi-Automatic Ground Environment) and BUIC (Back-Up Interceptor Control) systems. It will link U.S. Air Force surveillance radars, civil air traffic control radars, and Canadian radars into a shared system. Seven regional control centers -- each equipped with the smaller computers -- will monitor skies 200 miles beyond North American borders. An eighth center will monitor skies surrounding Hawaii.

The U.S. Army will save over $200 million by using simulators to train troops to use and repair Firefinder weapon-locating radars. The Firefinder detects and tracks enemy artillery and mortar fire with a pencil-thin electronic beam. It instantly backplots their trajectories so counterfire can be directed with pinpoint accuracy. The Firefinder trainer simulates battlefield conditions so troops can learn to operate the radar without using live artillery fire and without taking a radar out of deployment for instruction. Also, where only one student could operate an actual radar, six students can train at once under the control of one instructor. Hughes builds the Firefinder radars and trainers.

Mexico will inaugurate a national communications satellite system in 1985 with the launch of two Hughes spacecraft from NASA's space shuttle. The satellites will carry advanced telecommunications services for the entire country. Plans include educational and commercial TV programs, telephone and facsimile services, and data and business transmissions. Mexico now leases communications capacity on two other Hughes spacecraft -- an Intelsat IV from the International Telecommunications Satellite Organization and a Westar from Western Union. There are 157 satellite receiving stations operating throughout Mexico.

Paperless planning is making its debut to guide assemblers with step-by-step instructions for manufacturing electro-optical hardware. Color video monitors having twice the quality of home TV sets are replacing thick planning books at Hughes. The monitors are used in conjunction with video discs that hold up to 50,000 full-size color pictures, each equivalent to one sheet of planning. The discs store three-dimensional computer graphics or standard video. Assemblers can review still images or sequences showing how a product is to be built. Paperless planning is faster, more accurate, and less costly than conventional methods. It will also reduce manufacturing errors.

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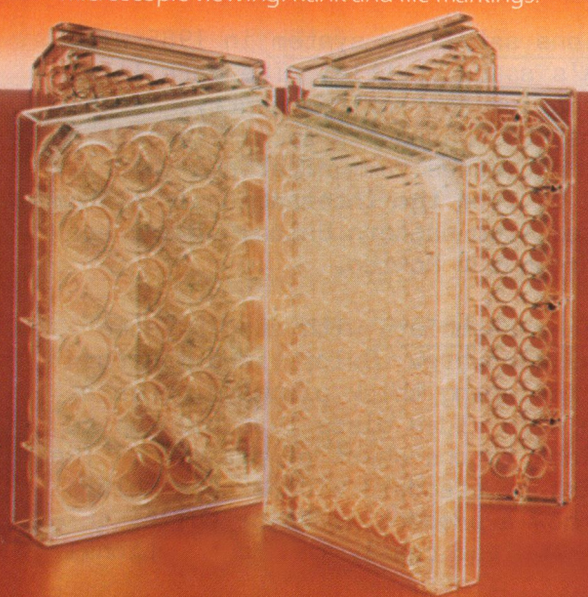

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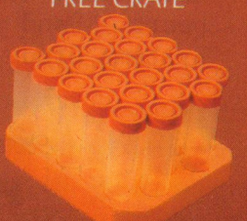

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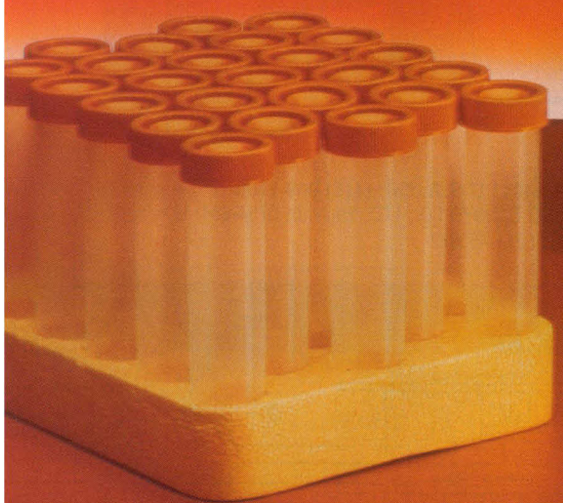

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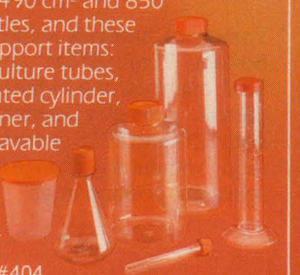

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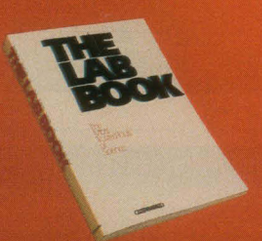

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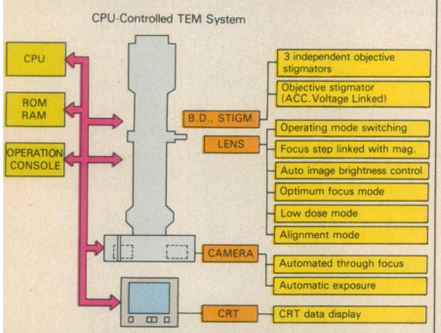

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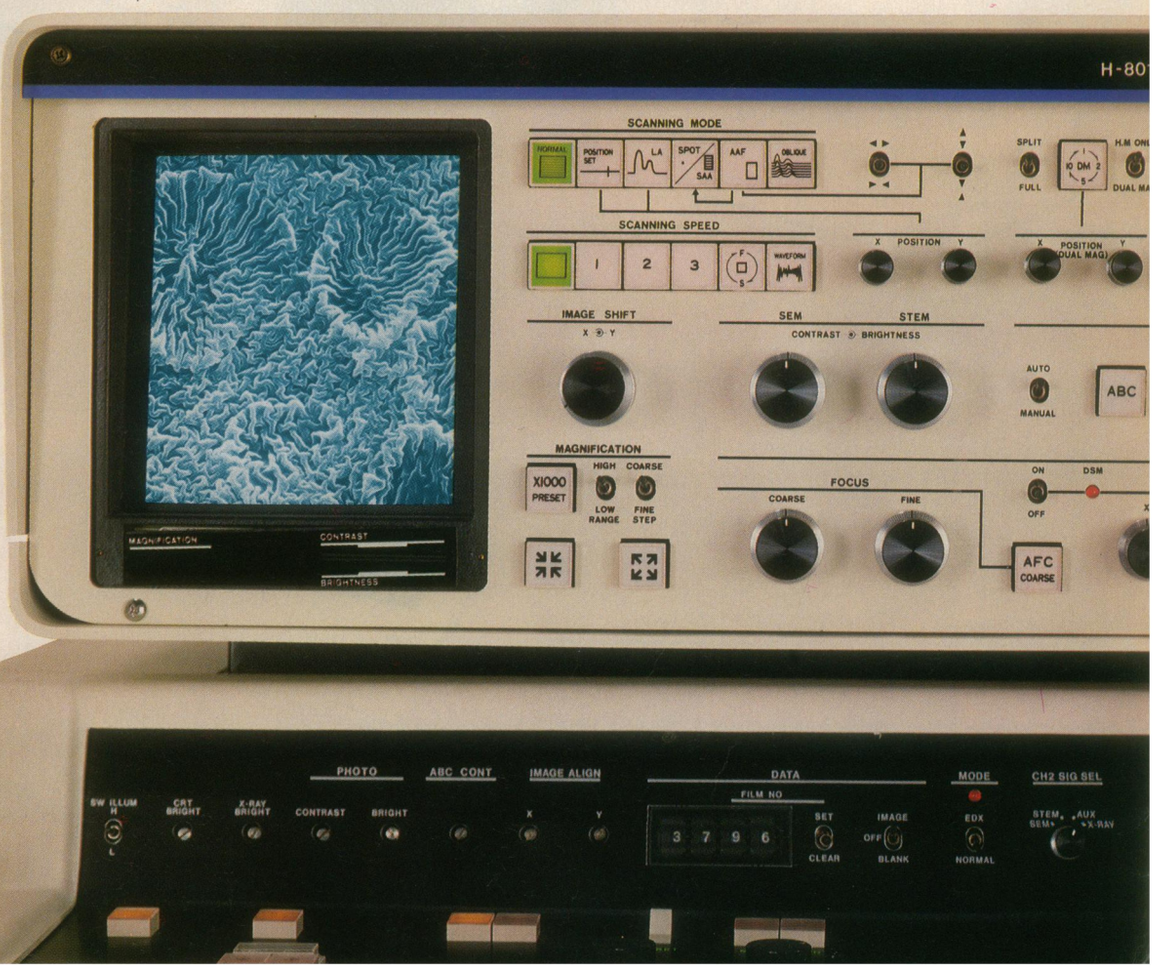

10 June 1983, Volume 220, Number 4602 **SCIENCE**

The Third Stage of Research: Auditing

Two of the three stages of federally funded research at universities work well. These are the selection process and the actual performance of the research. The third, demonstration of financial accountability, has not worked well in many cases. I think this disparity is the result of current auditing procedures.

It does not have to be this way. The Department of Defense, for example, long ago chose to place auditors full time on campuses for which it has audit responsibility. These individuals learn about the conduct of science as they review the spending that makes it possible. However, the approach of the Department of Health and Human Services, which audits roughly 95 percent of the universities, has been to send in teams of auditors for an intense scrutiny of the books every few years. This has frequently resulted in very large set-asides or disallowances. The fact that settlements negotiated later have been a fraction of the recommended disallowances has done little to ease the concern of some people in government that universities are not handling the money well.

There are, however, some changes in the wind. Last fall DHHS awarded 22 contracts to large universities to try out a new approach, with coordinated audits to be carried out by public accounting firms and, where appropriate, by university auditing staff working under approved guidelines. The results of these experiments should be available this summer. The Office of Management and Budget has created an interagency task force to see whether this approach makes sense for all agencies that audit federal research spending at universities.

Still unknown is what kind of guidelines or requirements will result. The options range from a brief summary of critical elements to supplement traditional auditing standards to a detailed manual of procedures spelling out every move. Also unknown is how the various participants will respond. For the university's managers and nonfederal accountants, the change means assuming greater responsibility for demonstrating financial accountability. It also involves a cost previously borne by the federal agency. For nonfederal accountants there is the opportunity to conduct audits that reflect a better understanding of the campus research environment than has been the case with many federal audits over the past decade. The perspective brought by these accountants to the audit assignment will be a key variable in the success of the new approach.

The role of federal financial and audit managers will remain crucial. They will retain responsibility for assuring Congress and the public that federal funds have been spent in accordance with the cost principles outlined in OMB Circular A-21 and other relevant regulations. But the coordinated approach entails ongoing consultation from the drafting of the audit plan to the issuance of the audit report. My experience has been that differences between the government and the universities arise less from cost principles than from nonnegotiable interpretations of these principles by the federal audit agency. The new approach can lessen this problem. It can also include current reviews (eliminating the need for extrapolation, which involves large financial stakes) and value prospective improvements over punitive disallowances.

What can faculty do during this time of change? I think their most useful contribution would be to ensure that the problems and perspectives of experienced faculty researchers are understood by those planning and conducting the audits. The review of research expenditures has become too important to be left solely to the accountants. Faculty have long been key participants in the peer review process and in directing the research itself. It is time they joined in shaping the reviews of spending which have eroded the university-government relationship in recent years. The next year or two will show whether all the participants make use of this opportunity.

—JOSEPH S. WARNER, *Director, Grant and Contract Administration, Yale University, New Haven, Connecticut 06520*

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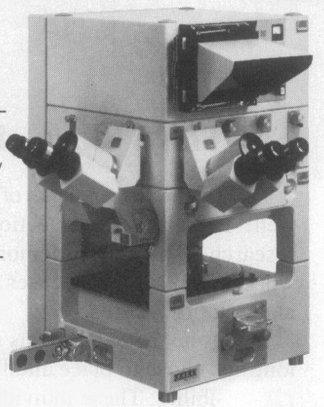

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