SCIENCE

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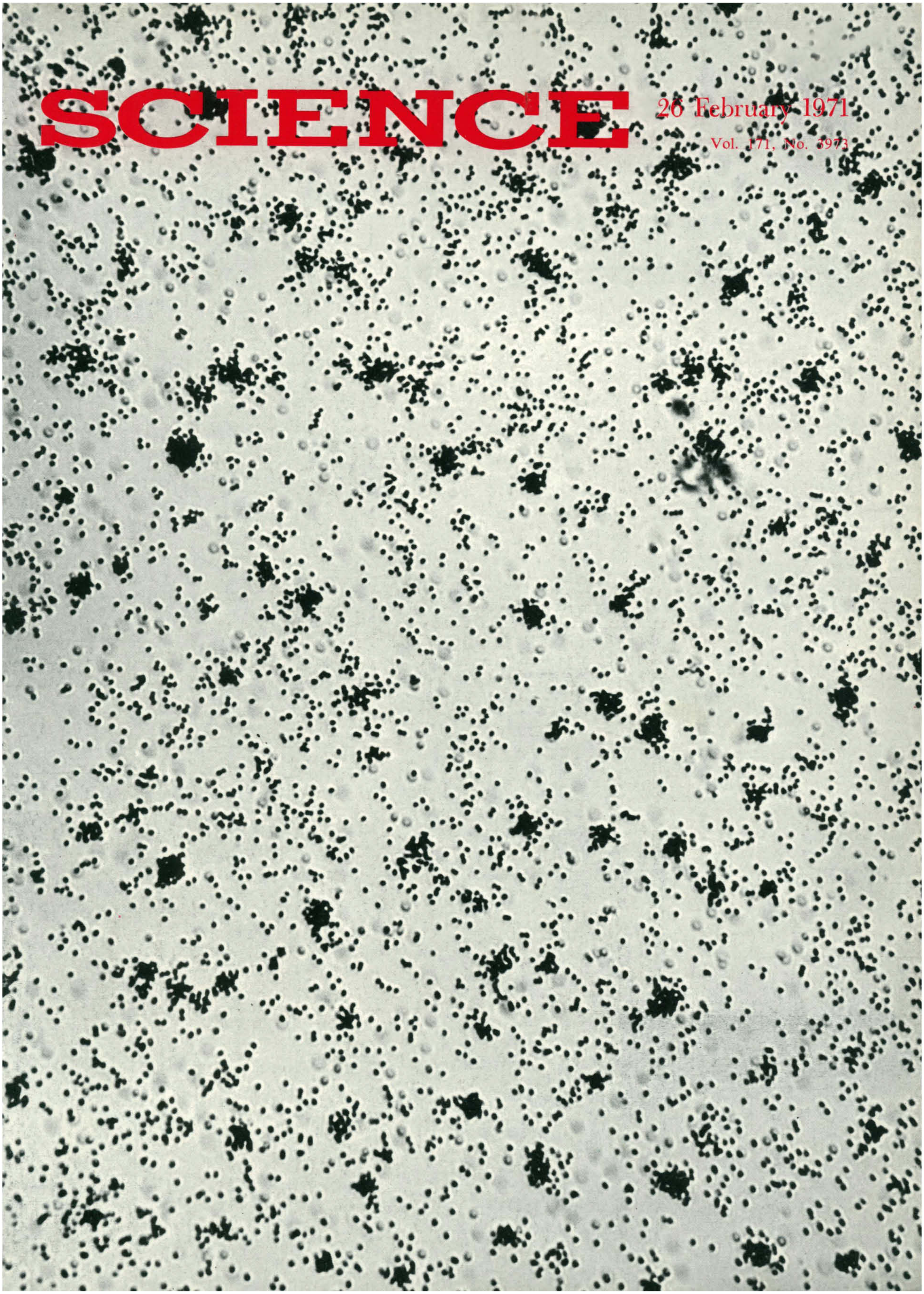


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SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Male gametes of the brown alga (*Ectocarpus siliculosus*) in a hanging drop preparation aggregate in clumps when the air surrounding the drop contains *Ectocarpus* sirenine. This compound, which is secreted by female gametes, is involved in the attraction of male gametes. The chemical structure of *Ectocarpus* sirenine has now been determined (10 millimeters corresponds to 70 microns in preparation). See page 815. [D. G. Müller, Max-Planck-I stitut für Züchtungsforschung, Cologne]

Some things are changing for the better.

A practical way to automate a GC lab . . . one step at a time

Although gas chromatographs (GC's) are designed and built for around-the-clock operation, the majority of them are used only a few hours each day . . . and never on Sunday. There are always good reasons for such under-utilization of expensive equipment. In this case, it's a matter of manpower: some one has to be present to inject a new sample into the GC; and every time an analysis is completed, some one has to spend about a half-hour translating the analog data of the recorded chromatogram into a meaningful quantitative analysis. Since most GC laboratories operate on a 40-hour week, it simply has not made good economic sense to add a second and third shift simply to realize a fuller utilization of the GC's.

But that's no longer the only solution. Some new instruments have recently appeared on the scene that allow you to triple the analytical output of your GC lab without increasing your staff or number of GC's. And you can do it a step at a time, as your budget allows, each step fully compatible with the next one.

First there's the 7670A Automatic Sampler. It measures and injects samples into your GC, completely unattended. The impact of the 7670A on the productivity of your lab can be dramatic: a single chromatographer can prepare samples and load them into the 7670A thirty six at a time, keeping the GC productive around the clock, even over weekends. Assuming a half-hour cycle per sample, he can produce well over 200 analytical runs a week, easily three times his best output with manual injections. If you're wondering about the reliability of the 7670A, don't. We have repeatedly performed 24,000 continuous automatic injection cycles with it in our laboratories—the equivalent of more than two years of unattended operation—without a failure. As an unexpected bonus, you'll also improve the quality of your laboratory's output because the 7670A's machine-reproducibility is consistently more precise than a skilled technician. Cost is $2850.

Then there's the 3370A Integrator. It automatically quantitates the GC analysis, prints an area count for each peak on the chromatogram and a total area count for the analysis, if desired. This cuts the chromatographer's computational load by about 10 minutes per sample (the time that it takes him to make area measurements manually). Apply this to a 7670A-equipped GC capable of producing 200 analyses a week, and you eliminate more than 30 hours of computation time . . . enough to pay for the 3370A, which costs $4950, in about four months. And you'll enjoy a further marked improvement in the precision of your GC analyses.

Next step in this modular approach to automation is the 3360A GC Data Processing System, an on-line data handling system whose HP 2114B Computer is fully programmed for GC. It processes data simultaneously from up to eight GC's equipped with 3370A integrators and automatically prepares a typewritten report of each analysis, including the name, retention time and % concentration of each component. The 3360A thus completely eliminates manual computation, cutting an additional 20 minutes per sample from the chromatographer's load (the time that it takes him to compute component concentrations manually and prepare a final report). To understand the potential impact of the 3360A on your GC lab, two additional facts must be kept in mind: the cost of the 3360A to a laboratory that has eight GC's already equipped with 3370A integrators is not $100,000 or $50,000, but less than $20,000 installed; and the 3360A is theoretically capable of processing more than 6000 analyses per month. Even if we assume that it will be used for as few as 1000 samples monthly, the 3360A will eliminate more than 300 hours of computation time from your manpower budget, enough to pay for the entire cost of the system in little more than 6 months.

Finally, for laboratories whose sample load does not exceed 500 per month, there's an even more economical way to automate data handling. By adding a hardware-plus-software option to your 3370A Integrator, you can automatically produce a computer-compatible punched paper tape record of integration data. You then feed the punched paper tape off-line to any of the principal time-share computers, using the BASIC language program provided, and automatically receive a complete report of the analysis, as with the 3360A. This cuts some 17 minutes of computation time per sample (in addition to the 10-minute reduction from the 3370A proper) . . . or a savings of some $1400 monthly based on a 500-sample load. Considering all costs—the $1550 cost for the 3370A option and the variable costs of the time-share computer lease—payout takes less than six months.

If you care to study in more detail the economics of HP's step-by-step automation for your GC lab, write for the Fall 1970 issue of *Analytical Advances,* a 32-page study of the subject.

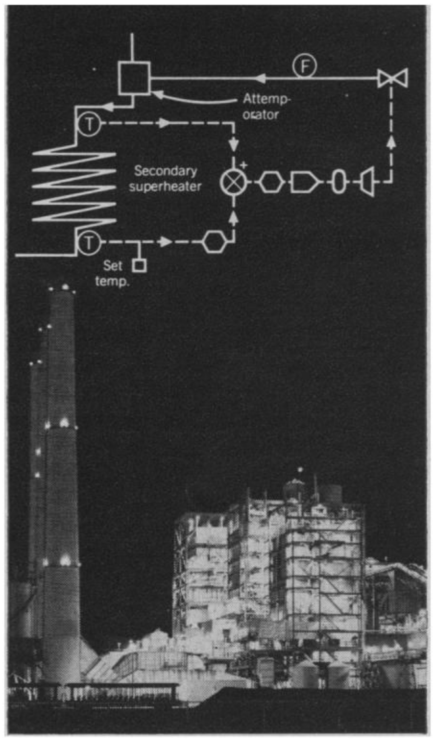
New tool for on-line control system analysis

(Note: To our Scientist Readers: The subject of the following article is a new instrument for continuous signal analysis that is useful in medical research, acoustics, radio astronomy and many other scientific measurements as well as in the process control application described.)

Very recently at a large power station in England, a system analysis of an attemperator (temperature control) loop was completed on-line, without disturbing plant output in any way. As the control characteristic of the loop was displayed on a screen during the experiment, adjustments were made to optimize control system response and the results were displayed immediately.

The job of the control system engineer—to predict how the system will react to a given input pulse—has not always been so easy. If he tested the system with a large enough impulse to produce a measurable response, plant output was changed in a way that could not be tolerated.

Some progress was made when control system analysts discovered the power of cross-correlation. With this mathematical technique, a test noise signal is applied to system input at such a low level that system output is not changed beyond normal background disturbances. Yet by cross-correlating



the test noise with system output over a relatively short period, the engineer is able to extract the impulse response of the system; background disturbances do not interfere because they are uncorrelated with the test noise. At first, cross-correlation did not help because it could only be accomplished after the fact, through off-line digital computation. What made the difference in the English experiment was the availability of two new HP instruments: a Model 3721A on-line correlator that's about as easy to use as an oscilloscope, and a Model 3722A precision noise generator that synthesizes repeatable pseudo-random noise, ideally suited to system analysis.

Correlation is fundamentally an averaging technique that is a powerful tool in recovering all kinds of periodic signals that are buried in noise, and in establishing a relationship between apparently unrelated signals. With the 3721A, the technique is easily applied *on-line* for continuous signal analysis in many kinds of scientific measurements. It might be useful in your work too. The Correlator costs $8325 and the Noise Generator $2650. On request, we'll be glad to send you a packet of information on these two instruments and a 96-page booklet on Discrete Signal Analysis.

Acquire and reduce scientific measurements automatically . . . without a computer

If you're a typical scientist, you spend a lot of time on the bench making measurements . . . and you don't object to that at all. What you do mind is the ever-increasing amount of time that you must spend at the desk making the calculations that turn raw measurements into useful information. Some scientists still rely on slide rule and adding machine for this work; some have acquired a 9100 Computing Calculator and, in one economical stroke, cut their computational load by half or more.

If you're in the second group, we'd like to tell you of a new way to liberate even more of your time for scientific investigation, by letting your data gathering instruments communicate directly with a data processing system. You might think that this will necessarily involve you in the cost and complexity of a computer.

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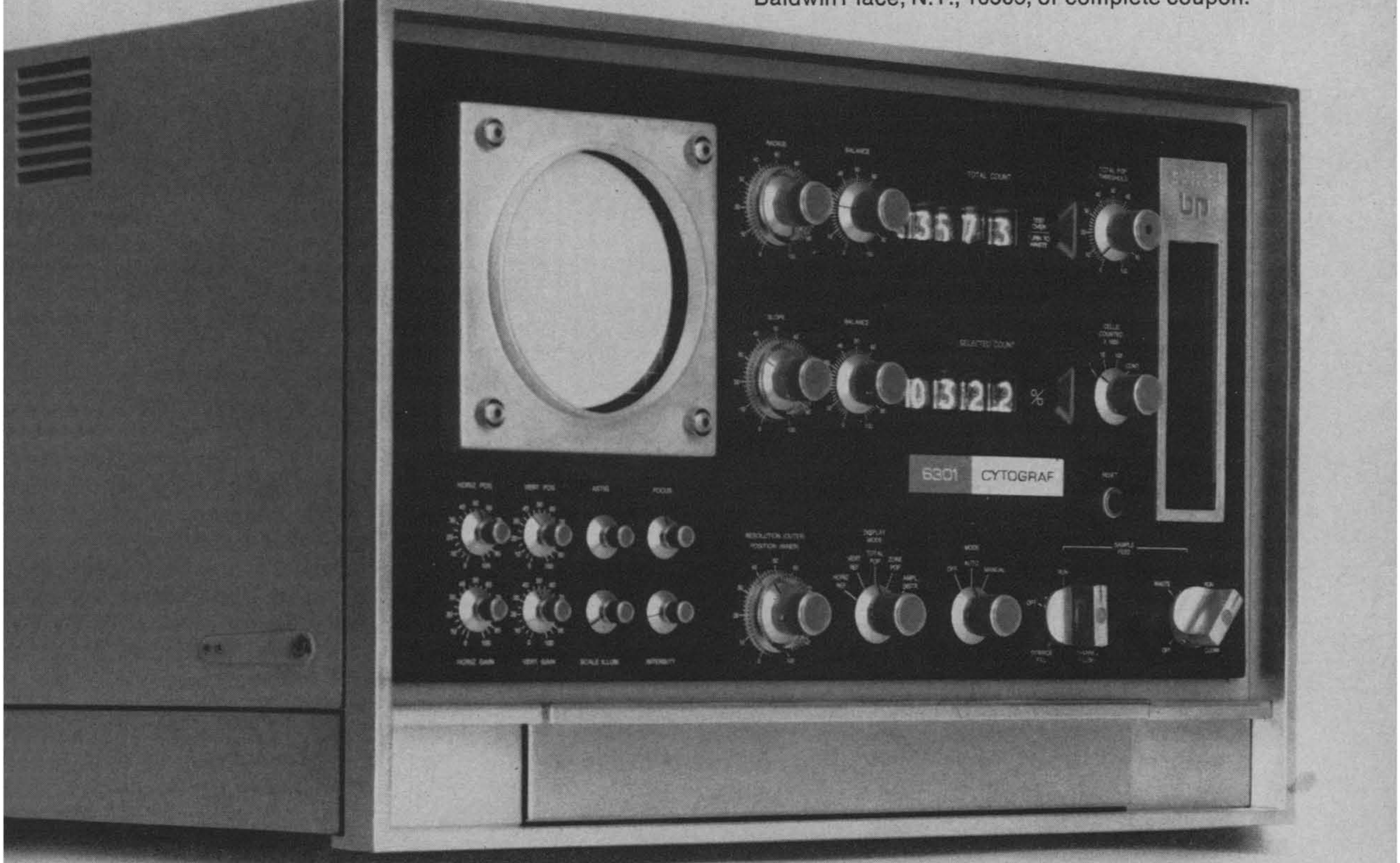

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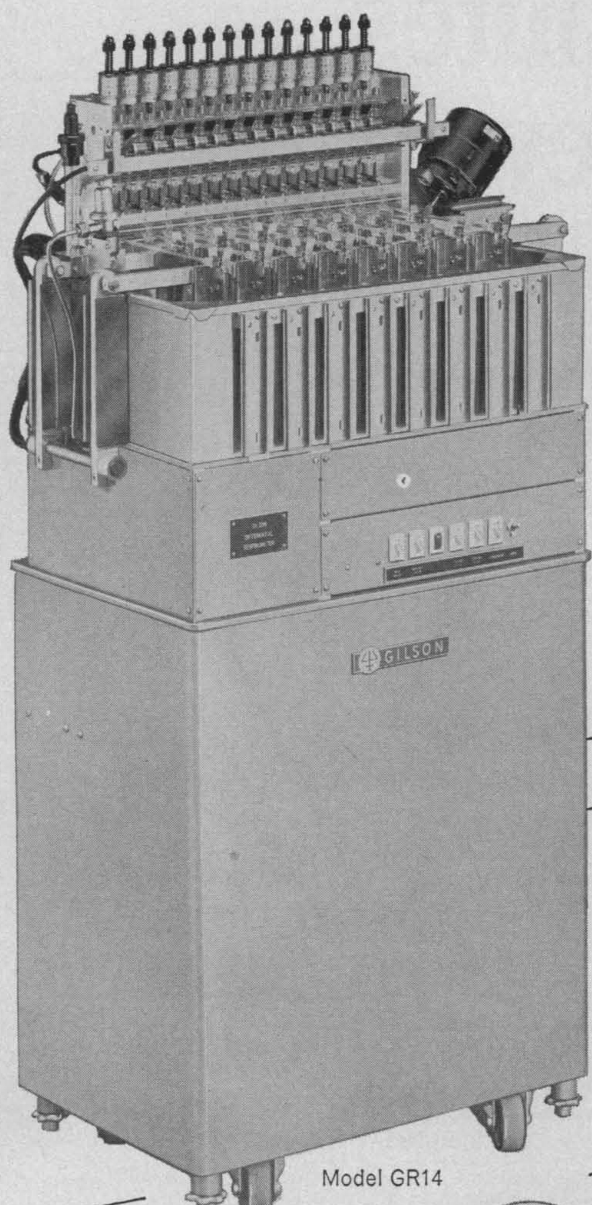

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SCIENCE

Governance of the Association

The Board of Directors of the AAAS has established a Committee on Governance (*1*) and directed it to "propose a revision of the Constitution and Bylaws of the Association to facilitate the expansion of the Association's program and membership and to improve the responsiveness of the Association's programs and procedures to the membership." The urgent need for this change reflects not only a more active involvement of the members in all affairs of the Association and explicit criticism of some of the current election procedures, but also a worldwide democratization of all human institutions—be they churches, universities, or professional societies.

The basic provisions of the present Constitution and Bylaws were approved in 1952 after a reassessment of the functions of the Association during the Arden House Conference called by Warren Weaver in 1951. The Arden House report (*2*) urged "the cultivation of synthesizing and unifying activities as the main emphasis of the AAAS in its internal work," and "to improve public understanding of science as the main external emphasis." The report of the conference strongly reaffirmed the objectives as revised in 1946. The present Committee is not inclined to change these.

The Committee on Governance consulted with the Committee on Council Affairs and the Board of Directors and, in December 1970, reported its plans and time schedule to the Council at the Chicago meeting. Two principles appeared to the Committee to be overriding for the years ahead. First, the AAAS must be a democratic organization in which members have a direct role, through elections, for determining who shall conduct the affairs of the Association on their behalf. Second, the Committee senses a decided trend over the last quarter century to markedly increase the role of the Association in advancing, through public understanding, the use of science for the promotion of human welfare.

The first major problem to which the Committee is seeking a solution involves membership and elections. Who shall be eligible for membership? Shall there be any differentiation among members for the purpose of governance? How shall principal officers of the Association be nominated and elected?

A second area of concern is the organization and management of the AAAS. The present Council has a membership of 540, the majority selected as representatives of affiliated societies. A poll of Council members in 1968 favored a reduction in size to between 100 and 200 members. It is urgent that we create a Council of workable size, which is selected by and directly responsible to the 133,000 members of the Association instead of predominantly to the organizations affiliated with AAAS. Such a Council could better serve as the primary legislative body of the Association, with the Board of Directors providing, as at present, the essential executive and management function.

Through this editorial the Committee earnestly solicits observations and suggestions from all members of the Association (*3*). A draft report from the Committee will be circulated to Council members for comment early in the fall. It is the Committee's hope that changes in the Constitution can be approved by the Council at the 1971 annual meeting in Philadelphia.—LEONARD M. RIESER, *Chairman, Committee on Governance*, and *Provost, Dartmouth College, Hanover, New Hampshire*

1. The Committee consists of three members from the Committee on Council Affairs: Merrill M. Flood, Lorrin A. Riggs, and Frank Bradshaw Wood; three members of the Board of Directors: David Blackwell, Leonard M. Rieser, and Kenneth V. Thimann; and a representative from the Youth Council: Mack Lipkin, Jr.
2. W. Weaver, *Science* **114**, 472 (1951).
3. Communications should be addressed to the Executive Officer, AAAS, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.

An important question is how many (and which) elements are sufficient to characterize a shard adequately. Sometimes, but not usually, one or two elements are sufficient. The clay found in a place in southern Israel, for instance, is characterized by a high hafnium content (12 parts per million), whereas most other clays contain only 2 to 3 parts per million. In an analysis of a group of Cypriot pottery, one piece was found to contain this high concentration of hafnium, and the rest of the composition was subsequently found to match the clay from Israel.

Thus far, 1400 pieces of Cypriot pottery have been analyzed to obtain a background on this type of ceramic ware. To provide a reliable analysis for an unknown Cypriot sample, an estimated 10,000 pieces will be needed. Similarly, an adequate study of the Mediterranean pottery would require about 100,000 pieces. The present rate of analysis is about 2000 pieces per year. The rate of analysis may be increased, but the difficulty of handling and, particularly, of recalling the information needed for interpretation of results increases with the rate of acquisition of data.

To achieve high accuracy, it is necessary to irradiate a calibrated sample, as well as the unknown, for comparison. About 2 years was required to develop a reliable, homogeneous sample of suitable quantity, one which had a representative composition and filled all requirements for such a standard. Analysis can be made on a very small sample, but usually a 100-mg sample is taken by use of a sapphire drill. Even this quantity is small enough so that it can usually be removed in an inconspicuous place, thus causing no visible damage to valuable pieces.

S. Fleming (Research Laboratory for Archaeology and the History of Art, Oxford University, England) described the thermoluminescence method of dating ceramics. This method, which measures the faint luminescence that is produced when ceramic objects are heated to a point where normal incandescence would interfere with the measurement (500°C), is intrinsically absolute. The luminescence is caused by the release of electrons trapped in crystal lattice defects in the clay. The electrons are trapped as a result of radiation occurring in the ceramic object. Alpha and beta radiation of relatively low penetrating power comes from radioactive material always present in clays; the gamma radiation, which has a substantially higher penetrating power, arises largely from the soil in which the object is buried. Average contributions of alpha and beta radiation are 0.22 and 0.19 rad per year, respectively, while the contribution from external sources (gamma and cosmic radiation) is on the average approximately 0.08 rad per year. Thus, about 16 percent of the total radiation to which the ware is subjected is caused by the environment. Because of the low penetration of the alpha radiation, it affects only the surface of the larger grains in the clay, and measurements are now made with samples from which the coarse grains have been eliminated by careful crushing and sieving and which, therefore, consist of grains with a diameter of about 1 to 2 μm. Alternatively, tests are made by using only coarse grains (about 100 μm in diameter) on the assumption that, of the intrinsic radiation, only the beta radiation has been effective. The calibration is performed by irradiating the material with a known dose and measuring the additional light produced on heating. The larger the ratio of light output on irradiation to that produced by the original sample, the less time has elapsed since the last firing of the ware, given an approximately equal background radiation contributed by the soil in which the object was buried.

In assessing the probability of authenticity, it is necessary to establish a minimum and a maximum age for the specimen. The criteria for authentication are (i) the minimum possible age may not overlap the documented era of forgery, and (ii) the maximum age must not exclude the archeological date of manufacture. The minimum age is given by the radiation experienced by ware that was buried at depths greater than 1 m in nonradioactive soil and that was therefore only affected by cosmic radiation. It amounts to 0.014 rad per year. The maximum external radiation is much more difficult to estimate; a figure of 0.17 rad per year is used. Usually great accuracy is not so important for questions of authentication, however, because the older specimens are normally the most interesting and the distinction between old and new is not difficult to make.

The size requirement for samples is about 25 mg, although measurements have been made on as little as 5 mg. A tungsten carbide drill is used for taking samples.

F. J. Turner (Department of Geology and Geophysics, University of California, Berkeley) discussed the petrographic character of classic marbles. His emphasis was on the potential value of petrographic studies in determining the provenience of marbles and, particularly, on some notable pitfalls in this connection.

Since there are only two, and in some cases three or four, additional minor components in most marbles, examination of thin sections under polarized light gives information on the mineralogical identity of the component grains and on their mutual geometric relations, which define the rock texture.

Marbles are formed by metamorphic recrystallization of limestones; statuary marbles usually contain 90 to 99 percent calcite, whereas some marbles have dolomite as their principal component. Different recrystallization temperatures, pressures, and periods cause different reactions with clay and silica impurities and result in minor minerals with characteristics that are readily identifiable with the polarizing microscope. Conventional chemical analysis, x-ray diffraction, and superficial microscopy are not diagnostic since they determine only the features that these materials have in common, not those that distinguish them.

Two problems that concern the archeologist are the possible geographic source of a particular piece of stone and the matching of fragments of marble objects. Texture, fabric, and mineralogy are the characteristics that are most useful for distinguishing marbles according to their origin. Differentiation according to grain size is not a good criterion since grain size is highly variable in individual localities and, sometimes, even in single thin sections. Twinning of crystals, however, is a function of recrystallization conditions, and it varies substantially from quarry to quarry. The shape and outline of the grains also provide a textural characteristic useful for differentiating marbles.

Probably the best characteristic for matching fragments of statuary or inscribed slabs is the "fabric"—that is, the alignment of elongated grains, or crystallographic parallelism even of nonelongated grains. Fabric represents a pervasive pattern of orientation of the principal symmetry axis of the individual calcite grains. Special and laborious techniques of microscopy and x-ray analysis must be used for such studies.

Mineralogical criteria do not give such positive information; therefore, differentiation by mineralogy depends heavily on the experience and background information possessed by the petrographer. However, where characterizing minerals are present, the experienced petrographer can usually identify them easily with a polarizing microscope.

Probably the most important contribution of petrography to identification of marbles is to rule out certain hypotheses. Occasionally a marble from a particular locality may have an unusual, and therefore diagnostic, mineral constituent, such as the red manganiferous silicate Piedmontite in a pink variety of marble from Mount Pentelicon. Since petrographic information is obtained with relatively low investment of time and special equipment, petrographic techniques should be considered important and useful adjuncts to other technological methods in the support of archeology.

Radiocarbon investigations of the La Brea Tar Pits were discussed by R. Berger (Institute of Geophysics and Planetary Physics, University of California, Los Angeles). Many Pleistocene animal fossils and the only human skeleton found in the La Brea Tar Pits in Hancock Park, Los Angeles, have been subjected to radiocarbon dating experiments. Because these bones were impregnated with an "infinitely" old asphalt, a special technique that makes use of the collagen of the bones was used to obtain a valid analysis. In the collagen method, the bone is washed thoroughly in petroleum ether, ground to powder, and dried in air. The calcium carbonate is removed by acidification, since the carbonate ion in groundwater can be exchanged with it and produce spurious results. The bone is then hydrolyzed in strong hydrochloric acid and refluxed overnight to obtain the amino acids in concentrated solution. The solution is passed through a chromatographic column packed with Dowex resin, which retains the amino acids. The column is washed to remove impurities, and the amino acids are then displaced with ammonia. The amino acids are burned to carbon dioxide, which is purified to eliminate impurities that might interfere with the counting. The carbon dioxide derived from the amino acids is then placed in the counter and measured. Gas chromatography is used to detect any hydrocarbons that might have slipped through. For greater precision, where sufficient sample is available, certain amino acids that occur only in bone, such as hydroxyproline, can be isolated chromatographically and used for analysis.

The collagen analysis was checked out on a quasi-mummified skeleton found in association with a bark mat in Nevada. The mat, the bone, the skin, and the hair were dated by conventional radiocarbon methods and were compared with the collagen procedure; the results were the same. The validity of dating of the La Brea fossils was further established by obtaining a radiocarbon date on wood fragments found in the tar pits; a comparison of fossil and wood gave very similar results.

The collagen method described gave an age of 9000 $\pm$ 100 years for the La Brea skeleton.

Further research along these lines has the following objectives: (i) find and date bones of little-known animal species; (ii) find how individual animal species change in their evolution over a span of 40,000 years; and (iii) look for other human bones or carbonaceous artifacts for additional dating studies.

G. H. Curtis (Department of Geology, University of California, Berkeley) reported that specimens of volcanic rock collected in 1969 at the principal hominid sites in Java (namely, Sangiran, Trinil, Ngandong, Ngawi, Jodjokerto, and Boetak) are now being dated at Berkeley. Owing to contaminants, mainly carbonate and zeolite which contribute large quantities of air, it has been difficult to obtain meaningful dates from most samples up to this time, but a fair date of 1.9 $\pm$ 0.4 million years for a tuff underlying the site of a mandibular fragment of Meganthropus can be reported. The Meganthropus fragments was found by P. Marks in 1952 in Djetis beds of continental origin near Modjokerto. Although the pumice tuff lies several meters below the hominid site, the site itself lies at least 400 m below late Pleistocene beds, all of which have been folded into an anticline and truncated by erosion, and it is believed that the pumice and hominid remains are penecontemporaneous.

The date of 1.9 million years makes this hominid, thought by many anthropologists to be an Australopithecine, contemporaneous with African hominids of similar evolutionary development. It seems reasonable to suspect that hominids were in Southeast Asia long before Meganthropus was entombed at this spot in Java.

In a discussion of lithomechanics and archeology, E. G. Thomsen (Department of Mechanical Engineering, University of California, Berkeley) showed that engineering analysis could be applied to archeological problems, and specifically to the reconstruction of methods for making tools and artifacts. The processes analyzed were the fracture of glassy materials in toolmaking, the use of stone flywheels in drilling, and the production of obsidian ear spools. In glassy materials, fracture surfaces show a consistency in character—demonstrated, for instance, by the prismatic obsidian cores found in many sites. Flint, obsidian, and other noncrystalline materials have no preferred orientation, however. Engineering analysis is able to show that, with knowledge of the fracture patterns of brittle materials (empirical in the case of early cultures), even primitive toolmakers could achieve the astonishing consistency of fracture patterns that has been observed.

Centrally perforated stone disks found in the southwestern United States may have been used as flywheels for drills. If so, the string drill, the twist drill, or the pump drill could have been known in early California.

Obsidian ear spools or plugs are among the most remarkable Central American pre-Columbian artifacts, because of their beauty, fragility, their paper-thin uniform walls, and their high axial symmetry. A relatively simple scheme was suggested for their manufacture: a rough, previously prepared and drilled core could be lapped by means of a self-centering mechanism, the principle of which may have been borrowed from weaving techniques that were well established in early antiquity.

Thomsen closed with a plea that appears applicable to the sense of the symposium: for continued and increasing exchange of the special knowledge developed in all disciplines.

FRED H. STROSS
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Note

1. This symposium, held 23 June 1970, was part of the 51st annual meeting of the Pacific Division of the American Association for the Advancement of Science, which met on the campus of the University of California, Berkeley. It was cosponsored and supported by the California Section of the American Chemical Society and the San Francisco Society of the Archaeological Institute of America.