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SCIENCE

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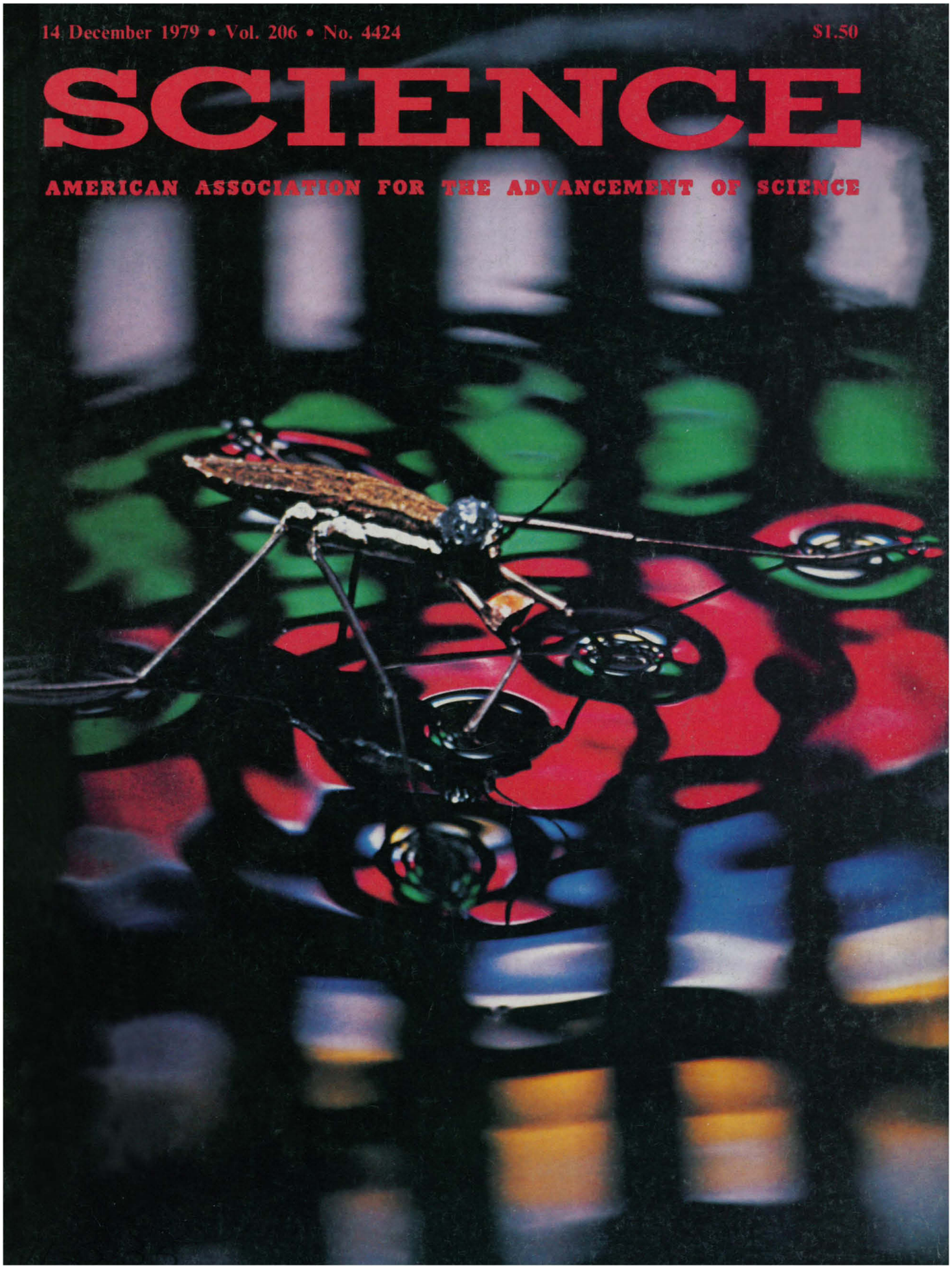

"The TJ-6 is an excellent product. We're delighted we have one." "It's centrifuge. Nothing ev with it." "You folks have the TJ-6. We're very happ the colorful tube adapters. , and a welcome change fr lt's a remarkably quiet-runn recommend a TJ-6 to any ." "The lift-out bowl alone e TJ-6 is an excellent p have one." "It's a very ning ever seems to to olks have done a fine ry happy with ours." "W adapters. They're easy t ange from previous types. quiet-running

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14 December 1979

Volume 206, No. 4424

SCIENCE

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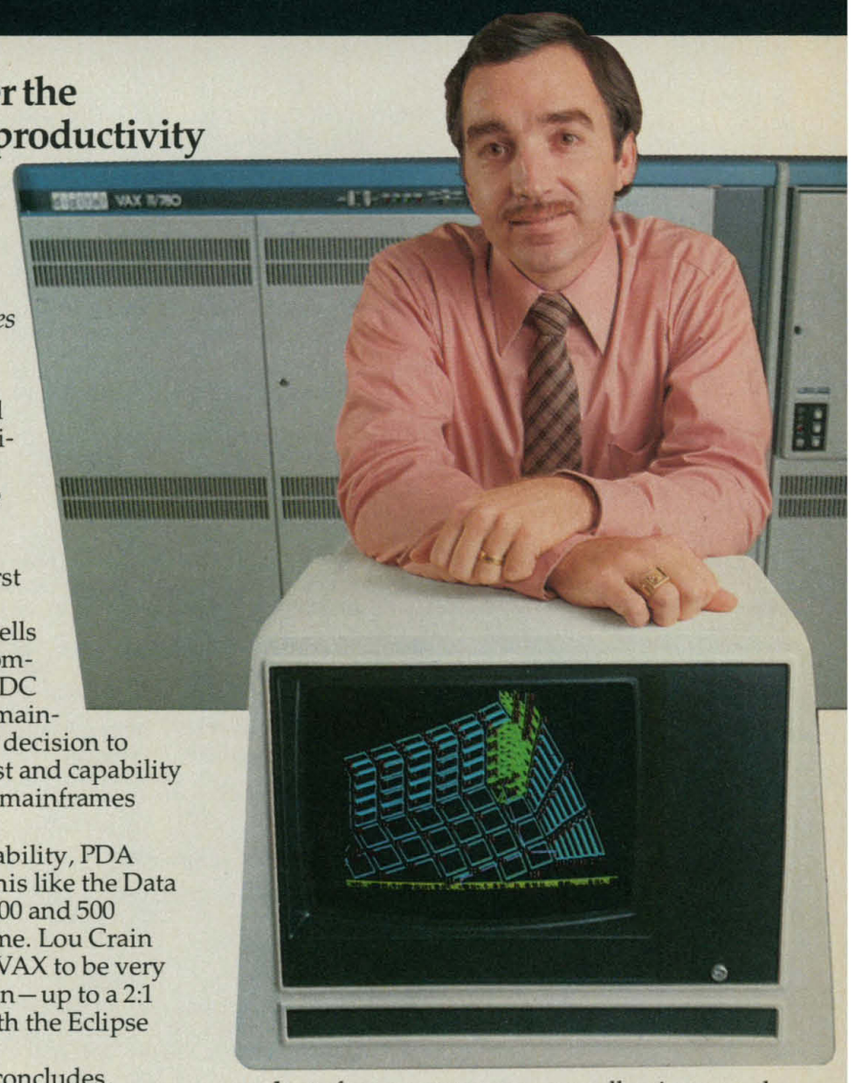
COVER

Masked water strider (*Gerris remigis*) with a samarium-cobalt magnet glued to its right foreleg. A computer-generated surface wave signal of ≥ 90 waves per second (highlighted by color bands) is imitating the male's signal through vertical oscillations of the magnet, which is driven by electromagnetic fluctuations from an encircling wire coil. Males can discriminate sex solely by presence or absence of this signal (body length of insect, about 14 millimeters). See page 1325. [R. Stimson Wilcox, State University of New York, Binghamton]

VAX Performance. Ask any user.

"VAX simply ran over the competition. In cost/productivity ratios, nothing even came close."

Lou Crain, Mgr. of Software Products
Prototype Development Associates
Santa Ana, California



PDA is an employee-owned engineering concern whose business ranges from fundamental research in structural analysis to the manufacture of critical aerospace components.

The VAX-11/780 is PDA's first in-house computer. Lou Crain, Manager of Software Products, tells us, "We've been doing all our computing through utilities using CDC 6600, Cyber 74 and Univac 1108 mainframes. The key elements in our decision to acquire the VAX-11/780 were cost and capability—compared to service bureaus, mainframes and competitive minis."

From the standpoint of capability, PDA considered traditional superminis like the Data General Eclipse and the Prime 400 and 500 series, plus a used 1108 mainframe. Lou Crain says, "Our benchmark showed VAX to be very powerful against the competition—up to a 2:1 performance advantage over both the Eclipse and the 1108."

"After installation," Crain concludes, "VAX has lived up to our expectations and has performed impressively. It's resulted in better products for our customers, as well as improved cost-effectiveness. Having our own interactive capability in-house has meant an increase in engineering productivity of up to 300%."

"VAX turns out to be twice the machine for the same amount of money."

Roger Vossler,
Section Manager and Systems Engineer
TRW Defense and Space Systems Group
Redondo Beach, California

Sensor data processing and distributed processing systems in support of real-time embedded applications are among the specialties of TRW's Defense and Space Systems Group.

To find the right computer, TRW continues to evaluate numerous machines—including Digital's VAX-11/780. They've also conducted numerous FORTRAN and PASCAL benchmarks.

In every test, VAX stands out as a clear winner.

Roger Vossler, Section Manager and Systems Engineer, says, "VAX is one of the best implementations we've seen of a successful integrated hardware and software system."

Since TRW's sensor data processing applications require enormous memories—over a million bytes to store a single image, for example—VAX's true 32-bit address space is vitally important. In addition, says Vossler, "VAX's I/O bandwidth capabilities are extremely important for effectively moving large quantities of real-time data at very high data rates."

Because TRW already had an investment in Digital technology, Vossler is particularly impressed with the relative ease of moving PDP-11 series programs onto VAX.

"But," says Vossler, "Even if I were starting all over again—without our Digital experience—I would still pick VAX, on the basis of its architecture, both hardware and software, and its impressive performance."

"Implementation was faster on VAX than on 25 other machines."

Brian Ford, Director
Numerical Algorithms Group
Oxford, England/
Downers Grove, Illinois

The Numerical Algorithms Group develops and maintains mathematical and statistical software libraries for customers in industry, science and academia.

Before VAX, NAG had implemented their complex Mark 6 Library on 25 major machines, including the Burroughs 6700, CDC 7600, Univac 1100, and the IBM 370. The average implementation time was 13 man-weeks.

VAX took five.

In Dr. Ford's words, "A successful implementation requires the correct functioning of the 345 library routines to a prescribed accuracy and efficiency in execution of NAG's suite of 620 test programs. Whilst the activity is a significant examination of a machine's conformity to the ANSI standard of the FORTRAN compiler, its main technical features are file creation, file comparison, file manipulation and file maintenance."

And implementation performance was just the start. Dr. Ford comments on VAX's impressive record of reliability after the program was up and running: "No problems were encountered in the VAX/VMS software even though approximately 3000 files were being handled. The operational availability time for the machine was close to 100%, an outstanding statistic for new hardware and a new operating system.

"VAX," Dr. Ford concludes, "is an implementor's dream."

Digital's VAX-11/780 has re-defined the level of performance you can expect from computers in its price range.

If your application requires large number crunching capability, high floating point accuracy, or lots of high-speed real-time calculations, there is simply no better system.

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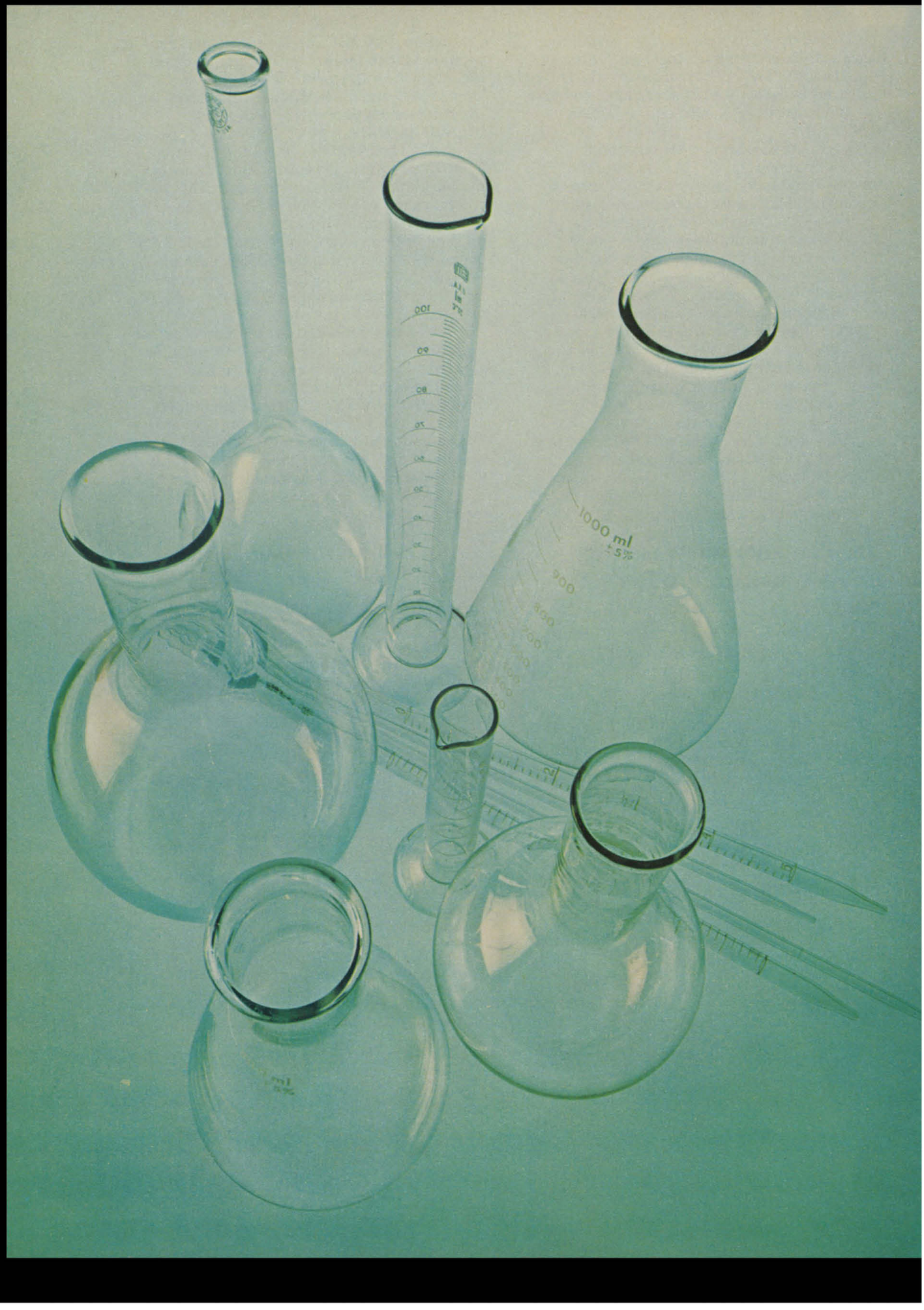
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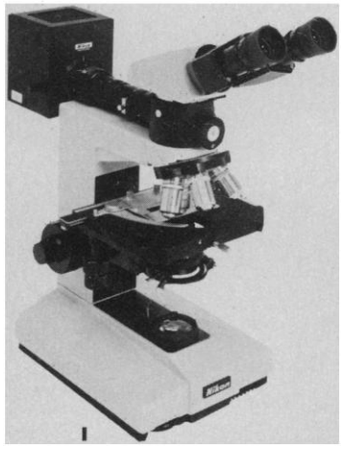

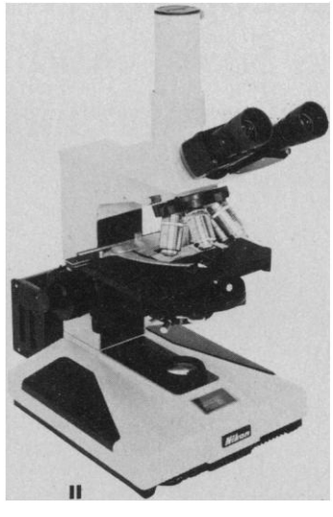

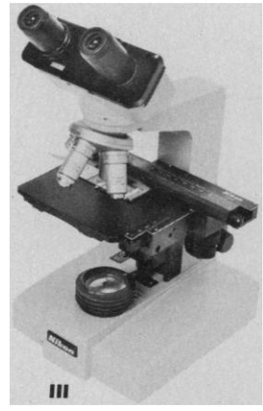

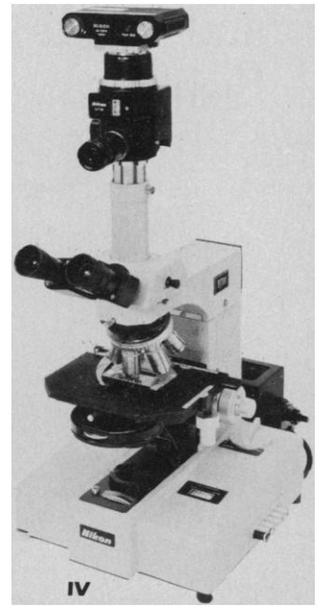

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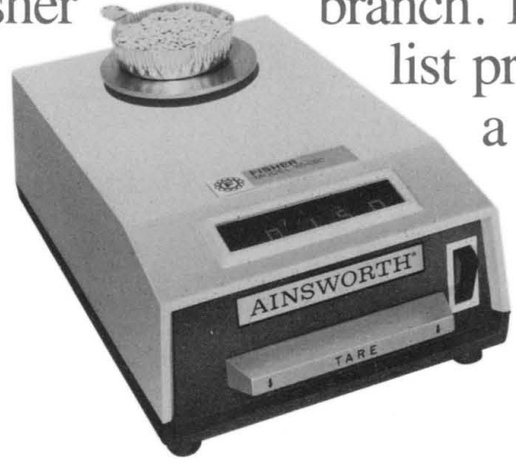

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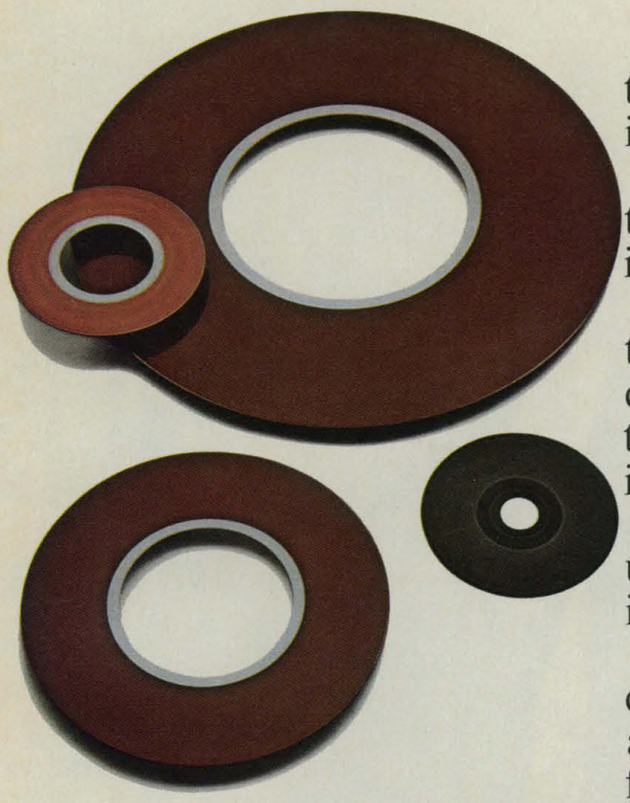
IBM'S GREATEST HITS.



These aren't the kind of "platters" they spin at discos. But they are recordings, and they've sold in the millions.

They're magnetic disks, and what they record is information for storage in computers.

They were introduced by IBM in the mid-50's and revolutionized data processing because they gave the user quicker access to his information.

Since then, disk storage has been universally adopted by the computer industry.

Without it, making airline and rental car reservations, credit card transactions, and 24-hour banking, to name just a few uses, would be all but impossible.

But the most important thing about disk storage is that at IBM we're still inventing it. Finding new ways to pack more information into less space, and retrieve it faster, all for less cost.

Today a single 8″disk (the small one at left above) can store as much information as 120 of the 24″ disks (the big one at the top) used in the first disk storage system we built. The 8″disk can, in fact, pack all the information on 22 newspaper pages into a space the size of a postage stamp!

Information that used to be stored at a cost of $150 can now be stored for about $1.

Technology has gone through the roof.

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Scientists and engineers find computer systems powerful tools and control.

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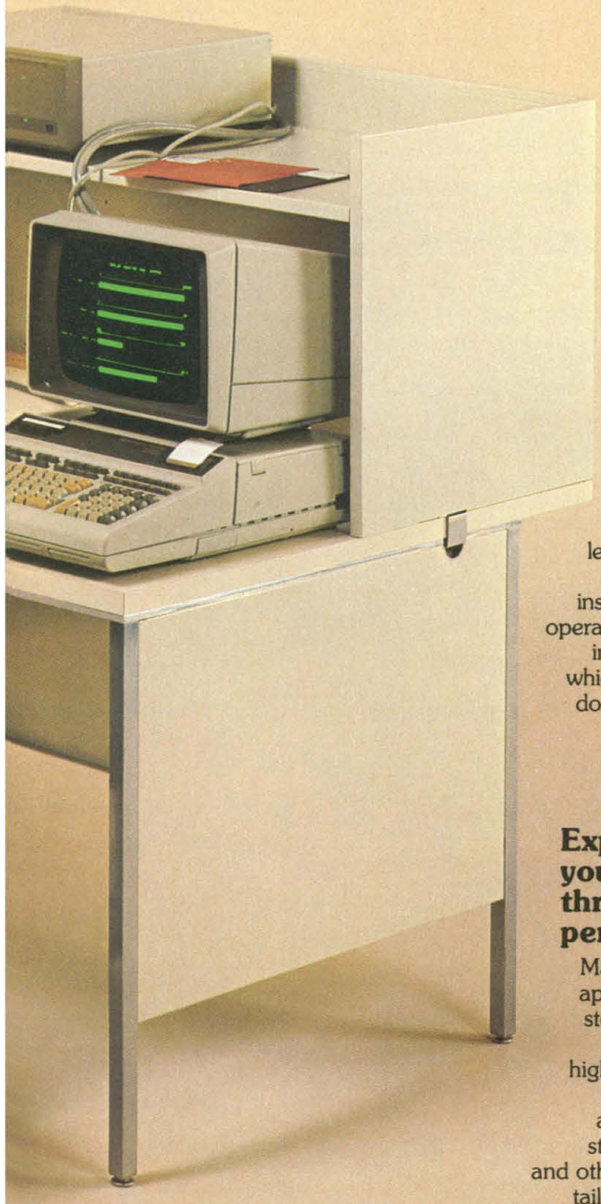
Interfacing power. Today's Hewlett-Packard desktop computer systems have such high performance interfacing features as direct memory access (DMA), vectored priority interrupt (up to 15 levels) and Enhanced BASIC and HPL programming languages. One model gives you up to 449K bytes of fully usable memory; another offers assembly language. Implementing your data acquisition and control system is as simple as choosing from one of four interface protocols on plug-in cards: HP-IB, Bit-Parallel, BCD or RS-232-C.

Days, instead of weeks. You can unpack a system and have it up and running on a production line, or in the lab in about one-third of the time you'd expect. Days, instead of weeks or even months.

From lab to production line. Once it's up, your test and control system can move with ease from one environment to another with no hardware or operating system changes. This kind of flexibility, coupled with the power and sophistication of today's models, makes an HP desktop computer the logical choice for your data acquisition and control needs.

Friendly. Together with the power to handle your big data acquisition and control problems, today's systems retain the reliability and ease of use that have always characterized HP desktop computers.

today's desktop for data acquisition



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HP-IB: Not just a standard, but a decade of experience.

HP-IB is much more than just HP's implementation of IEEE Standard 488-78. It reaches beyond IEEE-488-78 to cover the operational area as well as the mechanical, electrical and functional specifications. For example, HP-IB systems incorporate a built-in, high level I/O language that saves you the time and expense of writing instrument drivers and configuring operating systems. It means powerful interfacing through a system in which a lot of the work has been done for you.

Expand your system through HP peripherals.

Many data acquisition and control applications require external mass storage for large volumes of data. HP mass storage media include high speed flexible discs capable of handling data at burst rates and a selection of fixed discs offering storage up to 120M bytes. These and other input and output peripherals tailored for HP desktop computers allow you to configure the system that meets your needs today and accommodates future growth, as well.

A wide selection.

We build a broad range of desktop computers, with one just right for your data acquisition and control application. From the low cost HP 9815 through the HP 9825, the standard for HP-IB controllers; the HP System 35 with BASIC and assembly language; and the HP System 45B with advanced graphics capability, every HP desktop computer has superior interfacing characteristics in terms of human engineering, ease of use and power.

A growth path.

HP can meet expanding needs with communication links from desktop computers to HP 1000 series computers. For multi-user, multi tasking problems, HP 1000 systems offer a range of compatible RTE operating systems with software options for data base management, factory data collection and graphics.

For more information. Call 800-821-3777, extension 137, toll-free day or night (Alaska and Hawaii included). In Missouri, call 800-892-7655, extension 137. Or write 3404 E. Harmony Road, Fort Collins, Colorado 80525.

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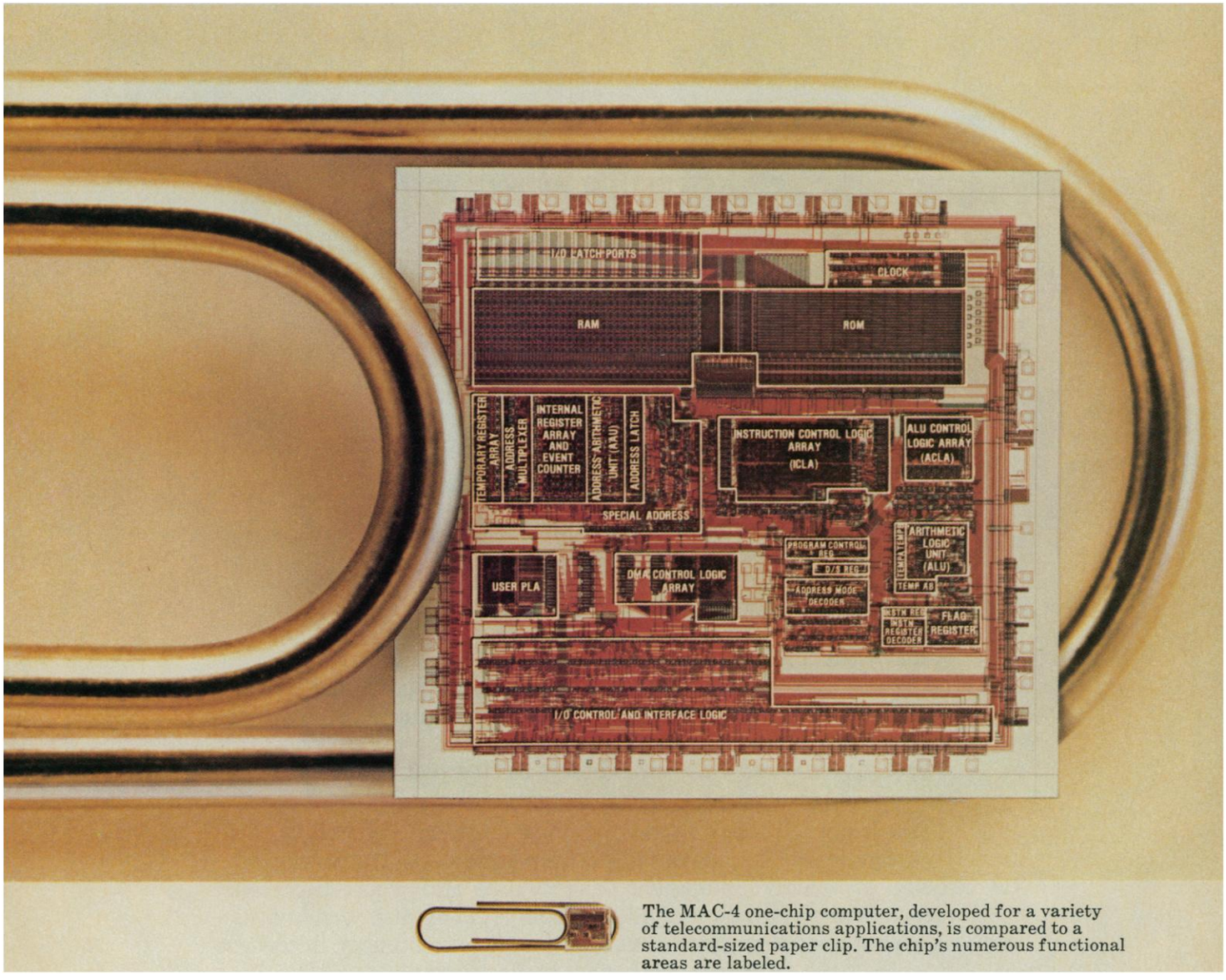
The one-chip computer: offspring of the transistor



The MAC-4 one-chip computer, developed for a variety of telecommunications applications, is compared to a standard-sized paper clip. The chip's numerous functional areas are labeled.

One of the transistor's latest descendants is the Bell System's 30,000-element MAC-4 "computer-on-a-chip." It's another in a long line of microelectronic developments that have come from Bell Laboratories.

The MAC-4 is so efficient that a program written on it takes 25 percent less storage space than that required by most other microcomputers. Its assembler language, C, also developed at Bell Labs, has features that make MAC-4 easier to program, debug and maintain. And the MAC-4 can handle anything from nibbles to bytes to words with its 4-, 8-, 12-, and 16-bit operations capacity.

Like other one-chip computers, the MAC-4 has sufficient memory to support its varied tasks—3000 nibbles of read-only memory and 200 nibbles of random access memory coupled to 34 input/output ports.

Fabricated with the latest CMOS technology, the MAC-4 needs little power. Thus it is well matched to a variety of telecommunications applications.

It started with the transistor

MAC-4 is just one current example of the many microelectronic devices to come from Bell Labs since we started the solid-state revolution with the invention of the transistor in 1947.

Over the past three decades, our advances in materials, processing, and devices have been vital to solid-state technology. These include:

- The Junction Transistor
- Crystal Pulling
- Zone Refining
- Field-Effect Transistor
- Diffusion
- Solar Cell
- Oxide Masking
- Thermocompression Bonding
- Photolithography
- Epitaxial Film Process
- Magnetic Bubble Memory
- Charge-Coupled Device
- Semiconductor Heterostructure Laser Used in Lightwave Communications
- Electron-Beam Exposure System

Today and tomorrow

Today, we continue to make important contributions to solid-state technology. For example, we've developed a rugged 65,536-bit RAM that can tolerate processing faults. Corrections can be made on the chip itself, so we can get more usable chips out of each manufacturing batch—and thus lower unit costs.

In materials processing, we've developed a technique for precisely controlling the growth of successive atomic layers of single crystal materials. This "molecular beam epitaxy" process is finding increasing use within Bell Labs and elsewhere in the electronics industry. We've used it to fabricate a device that permits us to double the speed of electrons by channeling them into crystal layers where they meet less resistance.

Other advances, in X-ray lithography and new resist materials, for example, promise to help place more elements on microelectronic devices and thus enhance their ability to perform important tasks.

As the solid-state revolution continues, these and other developments from Bell Labs will play an important part in it. What's important to us is the promise these advances offer for new telecommunications products and services. Like the transistor, MAC-4 and its solid-state relatives will find more and more applications in the nationwide telecommunications network.

For further information, or to inquire about employment opportunities, write: Bell Laboratories, Room 3C-303, 600 Mountain Avenue, Murray Hill, N.J. 07974.

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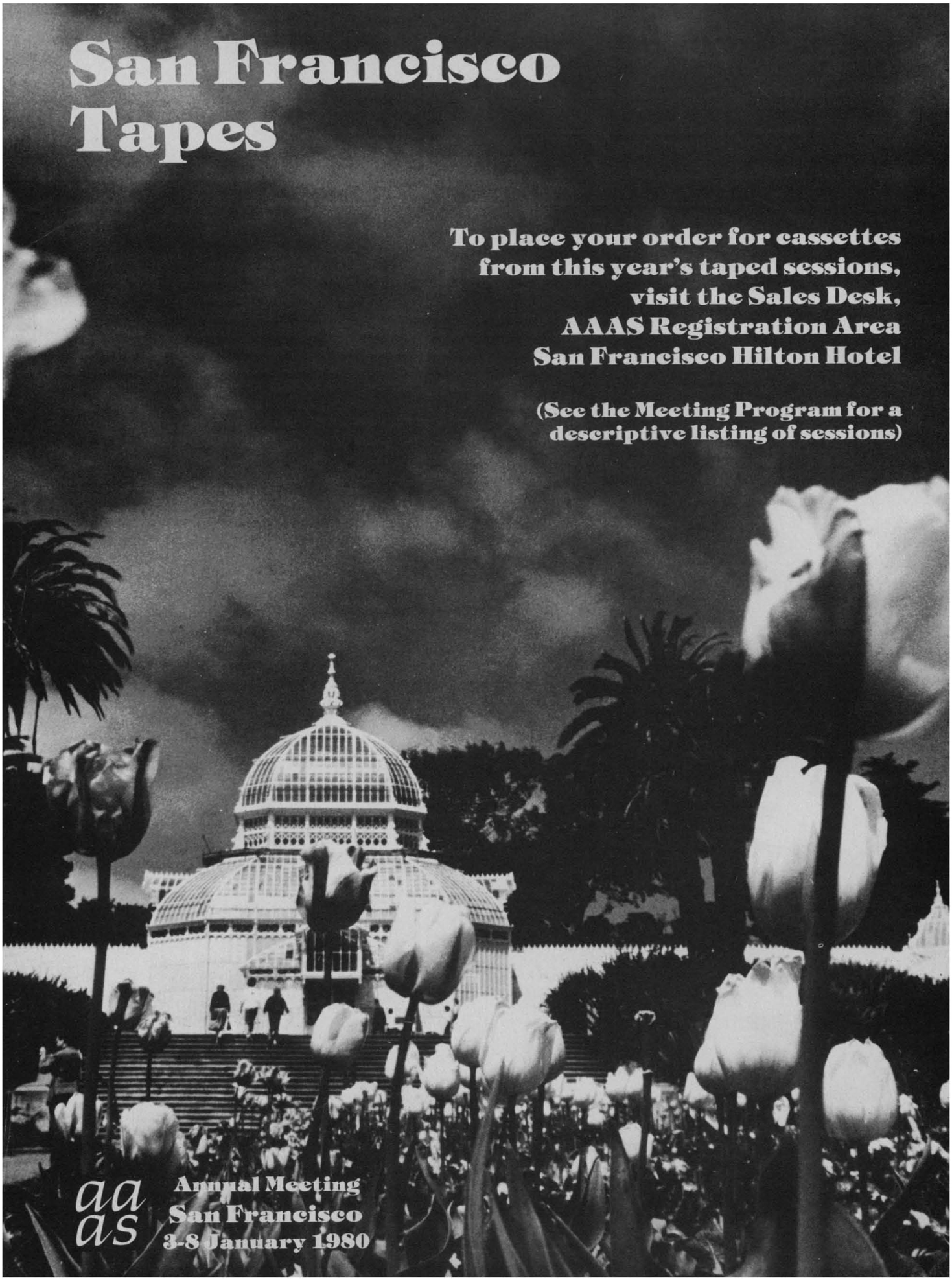
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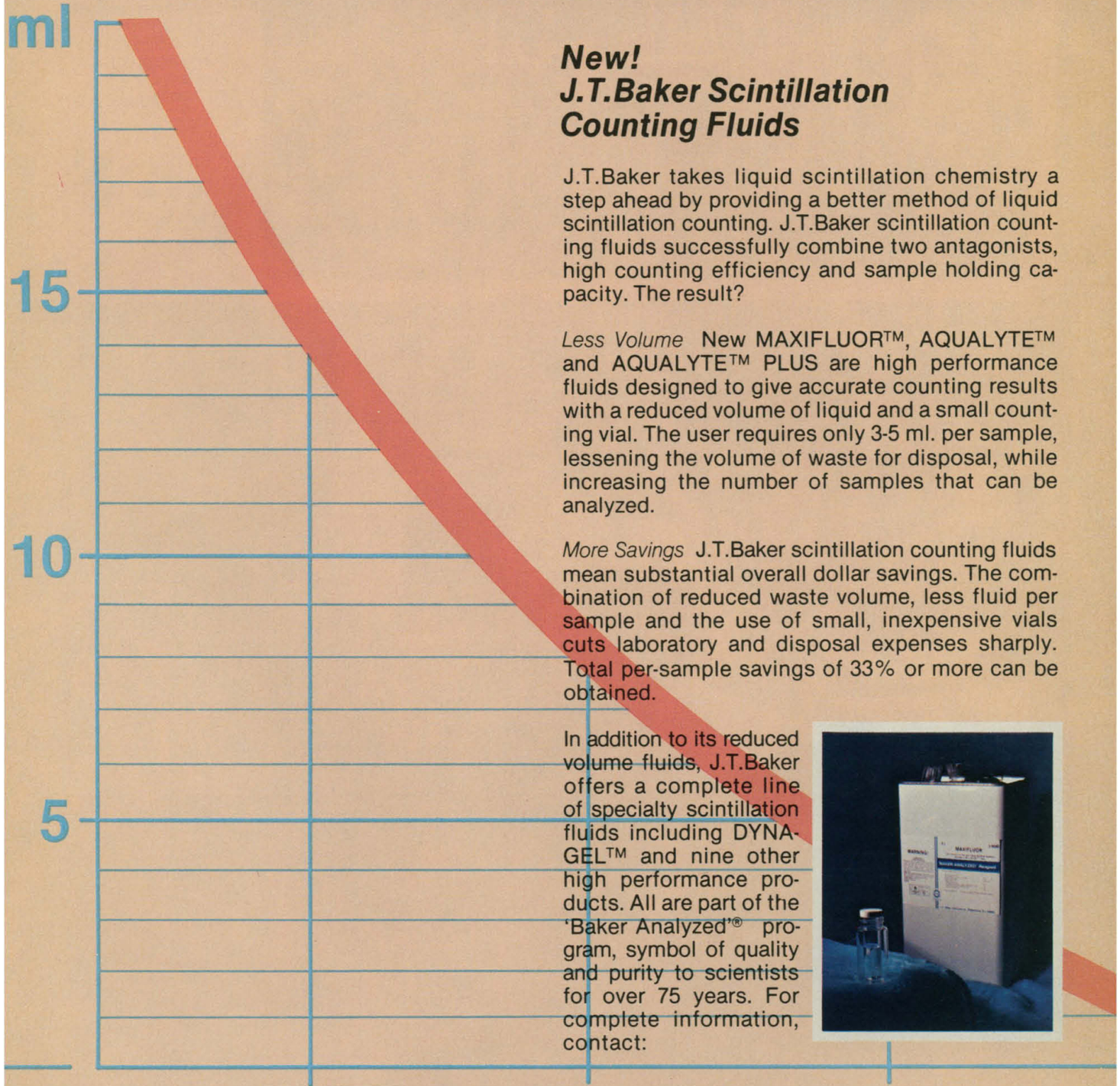

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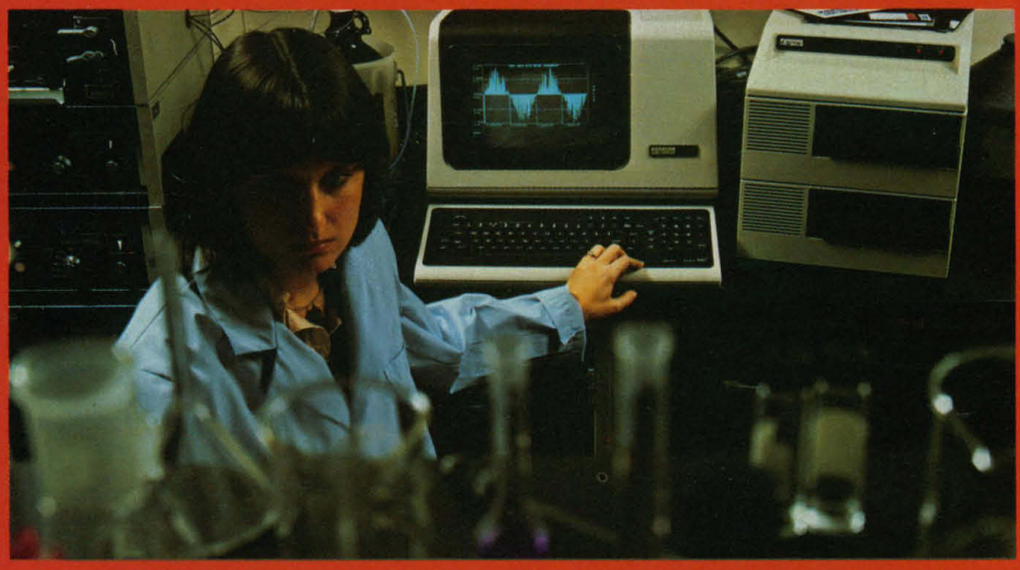

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Easy-to-use features:
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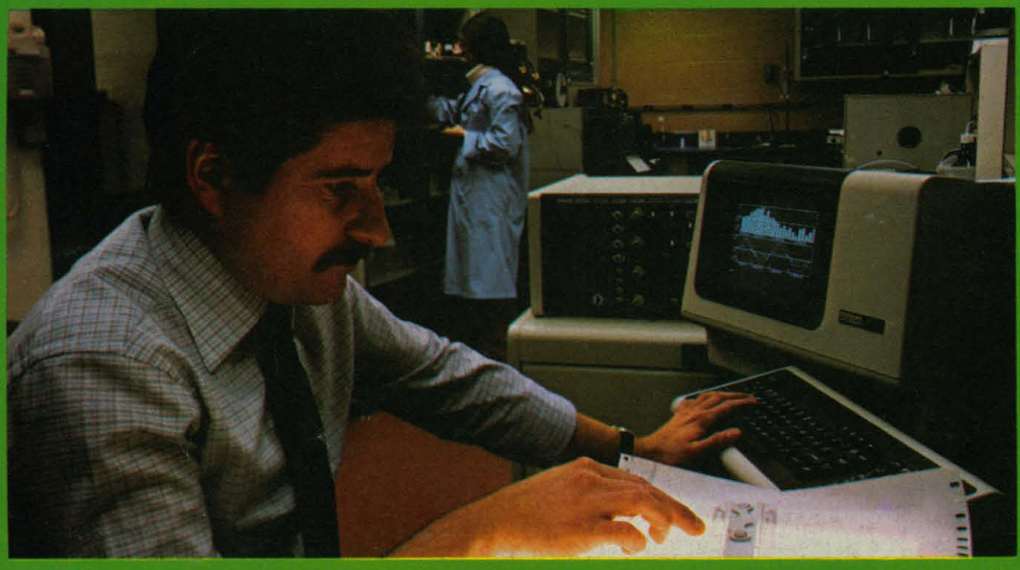

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LETTERS

Wistar Press: Comment on Closing

The following editorial will appear in the journals listed below. In each journal, the managing editor will sign first.

We, the Managing Editors of the Wistar Journals, on the occasion of closing of The Wistar Press, wish to express our appreciation to the many members of its staff. Each of us and uncounted authors have benefitted from their commitment on multiple levels to the communication of scientific information and to the highest quality of reproduction. We are sad to see the end of the era of service to the scientific community by The Wistar Press. Its staff can take satisfaction from the knowledge that they have made a lasting contribution to many fields of biology. We thank them sincerely and wish them well.

ROBERT L. BRENT
Teratology

SAM L. CLARK, JR.
The American Journal of Anatomy

MAXWELL W. COWAN
The Journal of Comparative Neurology

VITTORIO DEFENDI
Journal of Cellular Physiology

CARL GANS
Journal of Morphology

FRANCIS E. JOHNSTON
American Journal of Physical Anthropology

AARON J. LADMAN
The Anatomical Record

CLEMENT L. MARKERT
EDGAR J. BOELL
The Journal of Experimental Zoology

CARL GANS
Division of Biological Sciences, University of Michigan, Ann Arbor 48109

Food Additives

Two weeks after Philip H. Abelson's trenchant editorial, "Cancer—opportunism and opportunity" appeared in *Science* (5 Oct., p. 11), Michael Jacobson, director of the Washington-based Center for Science in The Public Interest, had this to say about our food supply: "I'd estimate that a maximum of 10,000 to 20,000 deaths per year could be attributed to artificial food additives" (*1*).

If 10,000 to 20,000 people die each year of cancer-causing food additives, I'd call that an epidemic. Abelson maintains that if food is a health problem it is related to naturally occurring substances and/or the cooking process.

It is just this type of contradictory information that leads to people's fearing the worst and, more damaging, to their being unable to evaluate risks.

Few are going to question where or how Jacobson obtained his figure of 10,000 to 20,000 deaths per year. It will be accepted as fact—because it's in

print. I've tried to corroborate his figures but can't. Not because no one will give me the data, but because no one appears to have them. Yet they are, thanks to Jacobson, now part of the public record—to be quoted and requoted.

I suspect it will take more than one or even a series of editorials in *Science* to change the public image of our food supply—a potpourri of carcinogens.

MELVIN A. BENARDE
Department of Community Medicine and Environmental Health, Hahnemann Medical College & Hospital of Philadelphia, Philadelphia, Pennsylvania 19102

References

1. Philadelphia *Bulletin*, 21 October 1979, p. 10.

Biotechnology and Profit

There is one aspect which I thought was omitted from the otherwise complete factual account by Nicholas Wade (News and Comment, 9 Nov., p. 663) of the founding, funding, and management of research of the smaller new biotechnological companies. Much of what these companies are doing is based on fundamental research, mostly the use of restriction enzymes in recombinant DNA work, research funded by public moneys, some of it I am sure in direct grants to some of the biologists who are now so involved with these companies. This is how it has been with pharmaceutical companies; there is no bar against this, but it seems to me that there is an ethical principle being violated. That principle has to do with the reason why public money is being spent on biological research; namely, that the fruits of this research will be available to the public who has supported it. Of course it will be available, but in the process, there will be profits, great and small, for the companies involved and, I gather, for some of the individual scientists involved. Of course the public will eventually benefit if, for example, a large supply of insulin is available; but at what price?

Now that these companies are set up and are going concerns, may I suggest to those scientists who either manage the companies, sit on their boards, or advise them, that they see to it that the profit margins to the investors are small; and that if large profits accrue, that these be placed in research funds to be plowed back into basic research, preferably to support young scientists who have not had the opportunity to dip into the public trough for private gain.

Finally, a debatable question must be raised based on the premise that there must be some avocations in a capitalistic society that are not tied in to the profit motive, and that scientific research, based on the socialistic principle of funding for the public good, must be one of them.

PHILIP SIEKEVITZ
Rockefeller University, New York 10021

Cancer Risk Assessment

The controversy over the appropriate method for assessing cancer risks, as described in *Science* (News and Comment, 25 May, p. 811), cannot be resolved satisfactorily without considering the diverse causes that can lead to an apparent positive result in a bioassay for carcinogenicity. Indeed, the very term "bioassay" is unfortunate, in that it implies that chemicals which are "active" share one particular characteristic that can be quantified and mechanically extrapolated to yield an estimate of risk. Such interpretations, though possibly appealing to the decision-maker, lack credibility. If experiments were perceived as "investigations" of biological activities, rather than as "bioassays," studies would be designed differently and would yield information more meaningful to risk assessment. The resulting estimates, based on recognition of the differing kinds of effects chemicals can exert on the whole animal, would appear more believable than the rigid mathematical interpretations currently proposed.

A helpful perspective on the issue is afforded by considering certain analogies to infectious disease. Bacteriologists distinguish between pathogenic organisms and those incapable of causing illness. They also recognize "opportunistic" pathogens, those capable of infecting a host only if the defense of the host has been weakened. Virulence depends upon several factors, including the host species, and bacteriologists will pause before concluding that the risk to humans is the same as that observed for another mammal. They certainly do not view all pathogens as representing an equal health hazard and know that the progression of an infection depends upon more factors than just the size of the inoculum (exposure). Death associated with infectious disease, just as death from cancer, frequently occurs under conditions (impaired defenses) which indicate that such infection should be viewed as a symptom rather than the cause of an organism's failing. Nobody

proposes to cleanse our environment of all potential pathogens; yet it is recognized that some must be scrupulously avoided.

"Positive" results in a carcinogenicity bioassay may arise for a variety of reasons. The chemical tested may be a potent carcinogen (true "pathogen"). It may be an "opportunistic" carcinogen detectable only because the defense of the host was weakened, for example, by senility or stress induced by a drug overdose; or the test substance may have *provided* the opportunity for an environmental or endogenous carcinogen to express itself. Any treatment which significantly influences the physiology of the rodent can change the pattern of background lesions in the senile animal. Insofar as tumors are a part of the disease pattern observed in old rodents, a difference in tumor distribution between medicated and control animals does not necessarily have a mechanistic basis that calls for zero exposure of humans.

The possibility that hormonal imbalance can influence tumor formation is well recognized (*1*). Stress alone can affect the tumorigenic response in mice (*2*), and it has been reported that the tumor incidence was higher in mice housed one per cage than in those housed five per cage (*3*). Some chemicals, particularly at high doses (*4*), may support tumor formation in rodents through stress-related mechanisms. The term "stress" may stand for several phenomena including the pharmacological activity of a chemical or the depletion of sulfhydryl groups needed for deactivating metabolites. Statistical artifacts are another source of difficulty that can lead to results incorrectly perceived as positive (*5*).

The results from carcinogenicity studies in our laboratories with many chemicals clearly indicate that no one mode of interpretation can serve adequately in every case. We have encountered chemicals that caused carcinoma at a time when untreated animals were still in robust health. Only relatively few animals were needed to detect this effect. When tests for mutagenicity (*6*) are positive, it is reasonable to conclude that such substances are "true" carcinogens (pathogens) in rats. Whether or not these chemicals would have the same effect in humans, or even in another rodent species, can, of course, only be a matter of speculation at this time. It is, however, prudent *policy* to assume that carcinogenic potential which coincides with mutagenic activity might also be expressed in humans, although differences in metabolism and host susceptibility make the estimation of potency in the human situation tenuous at best (*7*). In any case, prudence dictates that precautions should be taken to minimize human exposure to such chemicals.

We have also studied chemicals that appeared to influence the tumor *pattern* normally observed in old animals. Assessing the risk of such physiologically active agents requires a very different approach from that for genotoxic chemicals. One example, a potentially valuable drug, was labeled "carcinogenic" and barred from further development, although in a certain segment of the relevant patient population it would have been the treatment of choice. This compound was inactive in a battery of mutagenicity tests. Numerous observations established that it affected the endocrine balance of rodents. In a mouse experiment lasting 20.5 months, malignant uterine tumors were found only in control animals, and mammary carcinoma only in medicated females. Numerically, an untreated mouse had a threefold greater probability of dying with uterine tumor than a medicated mouse did of dying with a mammary carcinoma. The mammary carcinomas were seized upon to label the drug carcinogenic, although the incidence of all tumors, when results from both sexes were pooled, was 46 percent in control mice and 36 percent in the highest dose level group. The appropriate conclusion should have been that the drug at the high doses administered altered the pattern of tumor *distribution* by upsetting the hormonal homeostasis. Such data can only be meaningfully assessed in a manner very different from that appropriate for mutagenic carcinogens. Any application of one-hit or similar models is clearly inappropriate, while considerations familiar to pharmacologists of dose-response and interspecies differences most probably yield a realistic and credible estimate of the human hazard.

Other data support the thesis that a complete "biological" evaluation of carcinogenicity "bioassay" results is needed. For example, we know of compounds that appear to suppress tumors. A hypoglycemic agent showed such effects in mice and rats. Another agent, known to affect prostaglandin concentrations, caused diminished occurrences of spontaneous pulmonary tumors in mice, without concomitant increase in other tumors. Such findings clearly indicate that, while statistical treatments are valuable tools, they cannot be used in isolation from other facts in deciding whether or not a chemical should be considered a hazard. Pharmacological studies, tests for mutagenicity, and metabo-

lism experiments are essential in elucidating what causes tumors in the animal model. The implications to public health differ depending on whether one is dealing with a potent direct-acting carcinogen, or an opportunistic carcinogen capable of doing harm only to mammals of severely impaired resistance, or an agent providing the opportunity for ubiquitous carcinogens to become effective. The "bioassay" approach imposes a dogmatic and narrow interpretation of tumor incidences and discourages broader studies needed to advance our knowledge of what contributes to tumor formation. Only full consideration of physiological effects on a case by case basis can lead to credible risk assessment. An encouraging note is that Food and Drug Administration's advisory committees have provided flexible responses to "bioassay" data, pointing the way to more balanced risk assessments (*8*).

M. SCHACH VON WITTENAU

Safety Evaluation and Drug Metabolism, Pfizer Central Research, Pfizer, Inc., Groton, Connecticut 06340

References and Notes

1. I. Berenblum, *J. Natl. Cancer Inst.* **60**, 723 (1978).
2. V. Riley, *Science* **189**, 465 (1975).
3. C. Peraino, R. J. M. Fry, E. Staffeltt, *J. Natl. Cancer Inst.* **51**, 1349 (1973).
4. "Maximum tolerated doses" (MTD) are generally insisted upon for inclusion in carcinogenicity bioassays, and their effects are considered relevant to risk assessment. This appears to be an inappropriate application to biology of the mass law as known in chemistry. The MTD concept can be expressed as

$$\frac{(\text{animals}) \times (\text{chemical})}{(\text{tumor})} = K$$

In chemistry the mass law in this form holds only as long as first-order kinetics prevail. As it is well known that in biology the ranges for linear kinetics are limited, and because the development of tumors in response to an animal's exposure to a chemical involves many enzymatic and other processes, application of the mass law to tumor formation seems unsound, unless linearity of the relevant reactions has been demonstrated.
5. D. S. Salsburg, *J. Tox. Environ. Health* **3**, 611 (1977). "Using the standard formulation of tests of hypothesis, it is shown that there is a 20–50% chance of having a false positive. . . ." These are irreproducible artifacts. I would like to define a reproducible artifact as one which, though real, is not relevant to the question of risk from low-level exposure. A good example appears to be NTA (nitrilotriacetic acid), a chemical useful as a detergent additive which caused bladder tumors in rats when fed in concentrations above 0.7 percent in the diet. At these dosage levels NTA concentrations are so high in the urine as to cause the formation of calculi; R. L. Anderson, "Discontinuities of dose response curves in toxicological testing," paper presented at the Soap and Detergent Association 52nd Annual Convention, Boca Raton, Fla., 25 to 28 January 1979.
6. Rigorous proof for the causal relationship between carcinogenic and mutagenic activities of chemicals is still missing. However, attractive mechanistic theories and the generally good correlation between such activities suggest that short-term mutagenicity tests are useful for the assessment (as opposed to identification) of carcinogenic risk, in that probable mechanisms of action may be defined. Since many mutagenic and tissue-transformation tests are designed to be exquisitely sensitive, positive results in such experiments are expected to be obtained with those mutagens and/or carcinogens also, which should be designated as "opportunistic," that is, capable of doing harm to cells and organisms only under the most unusual circumstances.
7. The work of R. W. Hart and R. B. Setlow [*Proc. Natl. Acad. Sci.* **71**, 2169 (1975)] suggests a greater resistance of humans to carcinogens affecting DNA because of a greater capability for DNA repair by the human cell as opposed to that of the rodent cell.
8. See the summary minutes of the Food and Drug Administration's Toxicology Advisory Committee meeting on the role of prolactin in mammary carcinogenesis (12 to 13 May 1977) and the minutes of the FDA Endocrinology and Metabolic Drug Advisory Committee meeting on clofibrate-like drugs (15 to 16 February 1979) (available from the Supervisor, Public Records and Documents, Food and Drug Administration, Rockville, Md.). The FDA Drug Advisory Committee on Pulmonary-Allergy Drugs proposed (3 to 4 May 1977) the use of a class of drugs, some of which had caused tumors in rodents, and did not distinguish between "tumorigenic" and "nontumorigenic" compounds.

Mercury in Sperm Whale Meat

Japanese whaling interests have long resisted international whale conservation initiatives. A major argument used by the Japanese to support their plunder of great whale stocks has been that the meat is needed for human consumption (even though whale meat supplies less than 1 percent of yearly Japanese protein consumption) (*1*). However, data released by Masashi Taguchi of the University of Tokyo's College of Fisheries, at the June 1979 meeting of the International Whaling Commission in London, indicates that sperm whale meat offered for sale in Japanese food stores contains unsafe levels of organic mercury. The whale meat contained mercury levels of 2.3 parts per million, which is six times the level the Japanese government considers acceptable (0.4 part per million). . . .

Because of modern industrial activity, the world's oceans are polluted with mercury. This is not so important a factor in the contamination of fish with short life-spans. However, sperm whales live for 60 years and concentrate mercury in their flesh. When humans consume contaminated whale meat, the lipid soluble methylmercury is concentrated in the cells of the nervous system and very slowly eliminated from the body, even when all intake is stopped.

It is hoped that the Japanese will act on Taguchi's data. Their action could have the double benefit of protecting public health (*2*) and preventing threatened whale species from diminishing further.

JOHN F. BEARY III

Cornell University Medical Center, New York 10021

References and Notes

1. *The Whale Manual* (Friends of the Earth, San Francisco, 1978), p. 47.
2. *Brit. Med. J.* **1**, 599 (1978).

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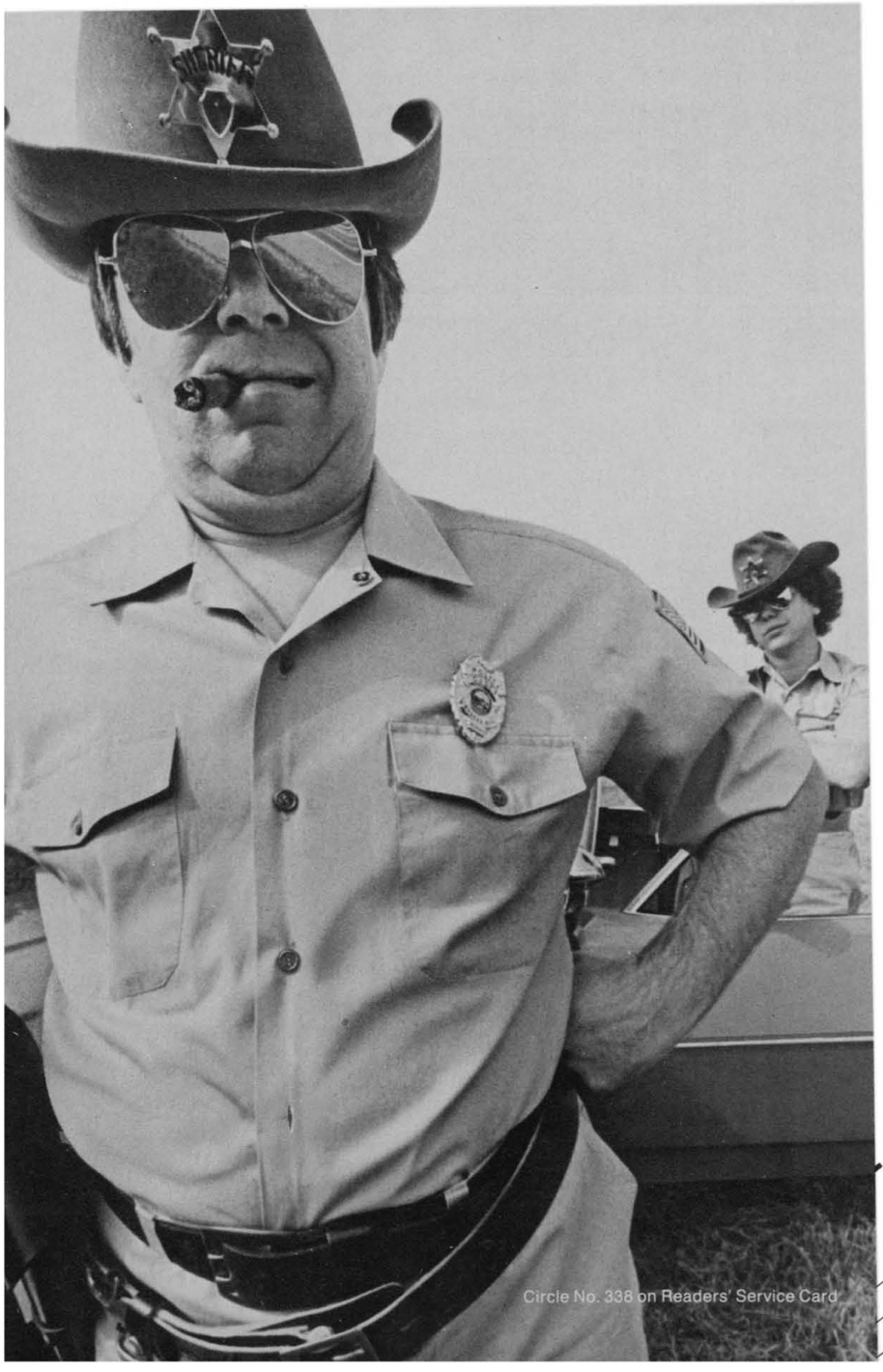

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"Guide for the Care and Use of Laboratory Animals." ILAR (NIH, DHEW Pub. no. 78-23).

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14 December 1979, Volume 206, Number 4424 **SCIENCE**

National Science Foundation Hearings

The current oversight hearings concerning the enabling legislation for the National Science Foundation have raised questions about the adequacy of the Foundation's present mandate and the role and composition of the National Science Board. The following observations are based on my experience as a university administrator, 10 years as a member of the National Science Board, and experience on the boards of several corporations and nonprofit organizations.

The mandate of the NSF is sound and ought not to be tampered with. It obliges the Foundation to support basic science research, as the only agency with that responsibility. At the same time it permits the support of applied research. During the 30 years of NSF's existence, its programs have changed with scientific developments and social needs.

The National Science Board has played an essential role in the successful performance of the NSF. It has set policy in all important respects. It interprets the NSF to its constituencies and those constituencies to the NSF. It has successfully protected the agency from potentially overwhelming penetrations—from Congress, the Executive Branch, and the research community. The NSF has responded to the nation's requirements, to the advice and counsel of the scientific community, and to the concerns of the legislative and executive branches of government. At the same time, the organization has been remarkably free from perturbations.

Those who recommend that the composition of the Board be prescribed by law have not given adequate weight to the fact that, over the years, the membership of the Board has changed as the size and composition of the science community and the subject matter interests of the NSF have changed. Its membership has reflected the national desire to include women and minorities in policy-making roles. The early heavy domination of the large research universities has been reduced. The process of Board selections, which begins with nominations (based heavily on suggestions from the scientific community) and terminates in the advice and consent of the Senate, has demonstrated the capacity to balance the many considerations that should be taken into account in appointments to a policy group so important to the nation. It is a political process in the best sense of that word.

There are two difficulties with the basically wholesome process of oversight review. The first is the disposition to make changes: all organizations can be made better, according to this line of reasoning. The other is the problem of finding disinterested parties. The present Board members and officers of the NSF and the scientific community are suspect of special interest if they defend the status quo. Critics inside or outside these groups, in turn, can be discounted as ignorant, spiteful, or disgruntled.

The final appeal must be to the actual performance of the Board and the Foundation over the years. The Board/Foundation mechanism was a unique government invention: a 24-member Board appointed for 6-year terms by the President, subject to the advice and consent of the Senate; a professional staff, most of whom are subject to Civil Service regulations; annual appropriations from Congress with final decisions concerning allocations made by the Board. The record shows that NSF is one of the nation's most effective government agencies, untouched by major fiscal scandals, singularly free from political uses, and highly regarded by the vast majority of the scientists, engineers, and educators who have had to deal with it. Its awards are generally perceived to be honestly and wisely made.

It is not my purpose here to speculate about the reasons this instrument has worked so well. The restraint of Congress and the Presidents over the years, the caliber of the Board and the staff undoubtedly were important factors. The total explanation is not available. Suffice it to say that it is a remarkable and rare structure. Until we understand more fully why it works so well, we would be ill-advised to change it.—ROGER W. HEYNS, *President, William and Flora Hewlett Foundation, Palo Alto, California 94304*

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