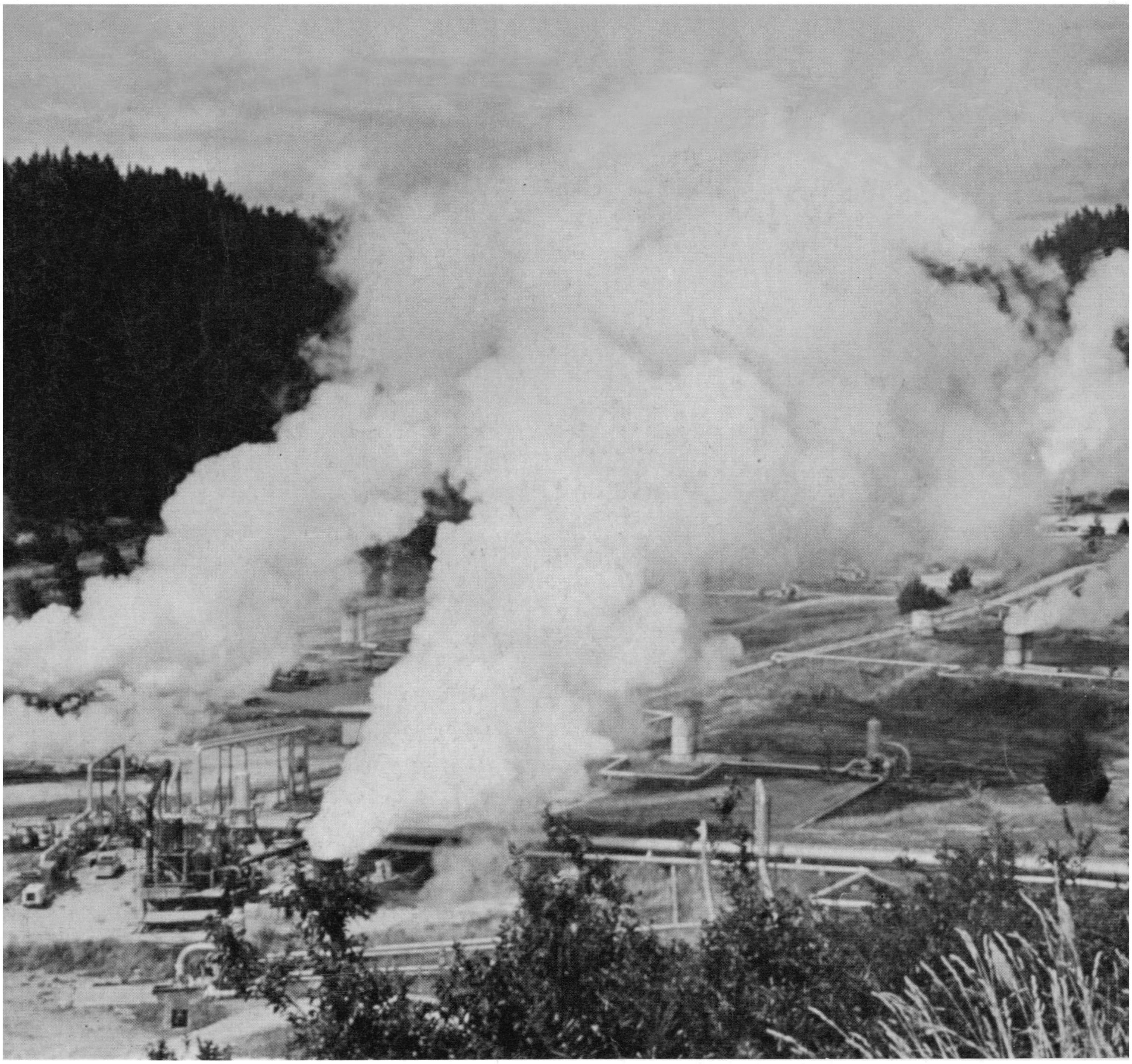
SCIENCE

7 March 1975

Vol. 187, No. 4179

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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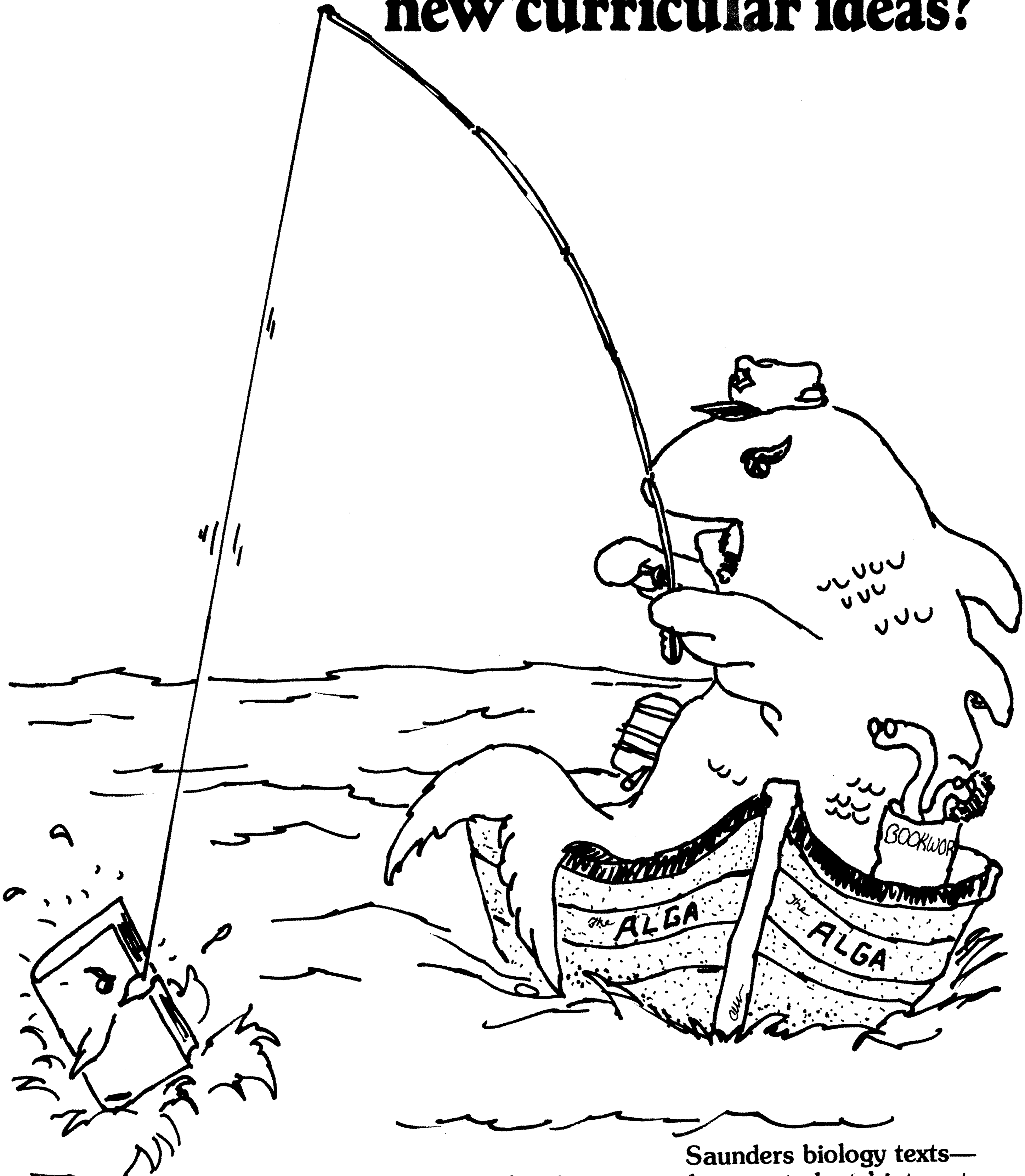

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Volume 187, No. 4179

SCIENCE

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COVER

Borefield (steam wells) at New Zealand's geothermal power plant. See page 795 [Robert C. Axtmann, Department of Chemical Engineering, Princeton University, Princeton, New Jersey]

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This new instrumentation recorder could be the only one you'll ever need. And it's so quiet all you hear is its purr.

Now that digital measurements are the thing, many laboratories find that they must add a digital recorder to their list of basic equipment. On the surface, this looks like only a minor complication, but it can become a big problem. If the scientist is not careful in making his selection, he may well find that he needs a different kind of digital recorder each time he acquires a new digital instrument.

Our new 5150A Thermal Printer can help you avoid this costly equipment escalation because it satisfies the vast majority of digital recording requirements. Take the problem of different instrument output codes for example. The 5150A handles most cases: it has plug-ins for direct interfacing with ASCII-byte serial and BCD parallel outputs. It will even accommodate a combination of the two codes.

The 5150A has a full 64-character alphanumeric printing set and 20-column capacity when equipped with the ASCII plug-in. With the BCD plug-in, it offers a choice of 10 or 20 columns, each with a flexible 16-character set. If the standard set won't do, it can be factory-programmed to meet almost any desired character need at low cost.

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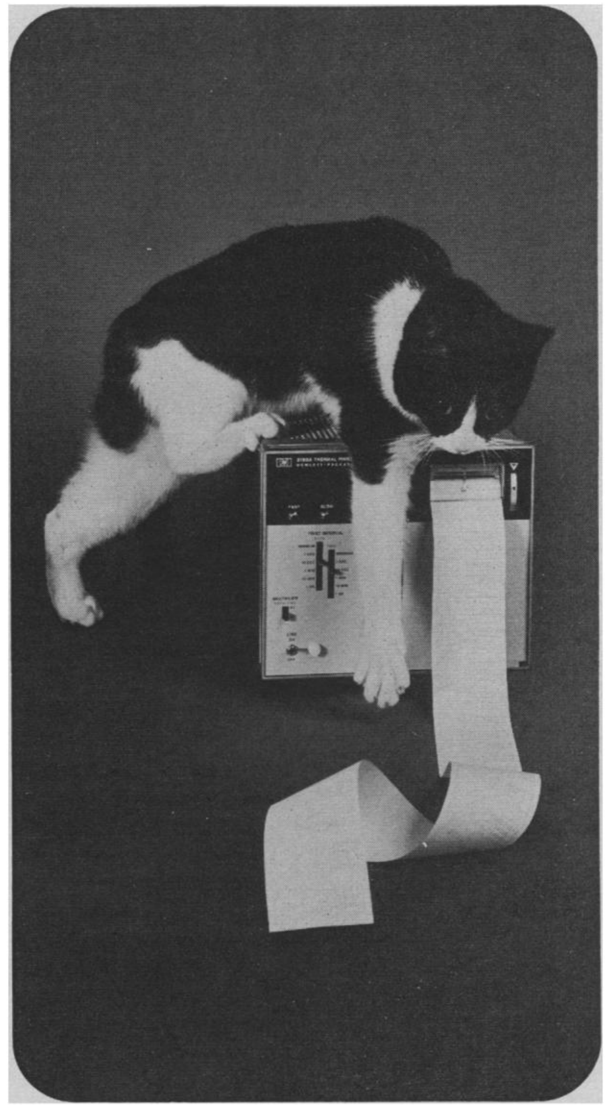

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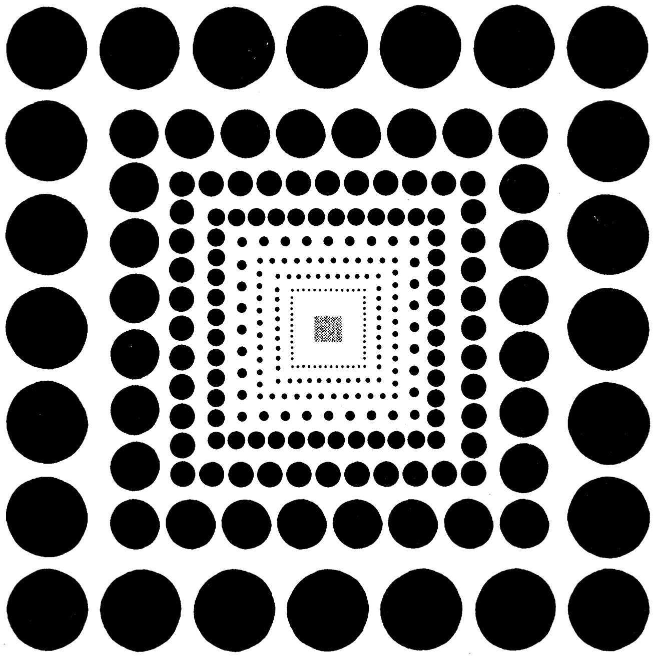

DOTS

or

Complexity is no longer objectionable

It began to happen quite recently. Engineers, realizing that the mythical mind of the well-programmed and capacious digital computer does not boggle, put it to work translating mind-boggling complexities of logic into physical form. The ancient philosophers who invented logic as a game that is all in the mind had perhaps never actually encountered minds that do not boggle. To put logical constructs into a physical form that is readily multiplied, one turns to a craft generally credited to Gutenberg. The particular physical form, whether a metal-oxide-semiconductor (MOS) chip, a bipolar integrated circuit, or a charge-coupled device (CCD), rests also on subsequent contributions by the artists who invented photography, by the inorganic chemists who vied to discover new elements in rocks, by the physicists who invented quanta and electrons to explain their experiments, by the organic polymer chemists, even by us in one small way or another.

The physical form comes down to a bit of jewel patterned in lines and dots much finer than those by which a printing press prints pictures. The scanning electron microscope discloses thousands of electronically active and passive components tied together by logic. Economies of duplication and size for costly materials of the rarest purity open mass markets for all manner of artifacts that interact with the customer's central nervous system, homunculi who live in tiny boxes and are looking for new work beyond telling time and performing difficult calculations. When complexity is affordable, one can do almost anything.

The technology that generates the dots for the printing press turned out to be the way to carve and deposit the patterns the computers generate. From serving the printing and graphic arts industry for a long time, we know that technology well and currently serve the photolithographic departments of today's electronics industry not only with high-resolution plates and light-sensitive resists but by encouraging communication within their craft.

Here, for example, are the titles of papers presented at the most recent of the Kodak Microelectronics Seminars:

- The "Oxygen Effect" in Photoresists and Its Manifestation in Processing Parameters
- A Laser Reticle Generator
- Performance of an EBPG (Electron Beam Pattern Generator) as a Link in a Semiconductor Chip Manufacturing Chain
- Mechanistic Aspects of Photocrosslinking in Negative Photoresists
- Modelling Positive Photoresist
- An Electrical Method for Detecting Pinholes
- Effective Water Removal from High-Resolution Plates
- Advances in Contact and Proximity Printing
- Holographically Prepared Gratings for Integrated Optics
- Chrome Is for Car Bumpers and LSI Mask Technology
- The Characterization of Positive Photoresists
- Processing Techniques
- The Chemistry and Control of Processing High-Resolution Plates
- Lenses and Optical System Used in Microelectronics
- Monosubstituted Vinyl Polymers as Highly Sensitive Negative Electron Beam Resists

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Kodak

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Mineral Research in Turkey

Attending a meeting in Ankara during February was no holiday. Going and returning, about half of a group of 16 had some kind of mishap—lost luggage, canceled flights, or missed connections. Ankara was cold, electric power was intermittent, and there was a heavy acrid smog.

Despite these handicaps, visitors came away with a favorable view of Turkish vitality and enterprise. They were especially impressed with the Mineral Research and Exploration Institute of Turkey. The institute, known locally as MTA, is an important factor in the development of the country.

In 1935 when MTA was formed, there were practically no indigenous geologists in Turkey. Today MTA has a staff of about 3000, of whom about 1000 are Turkish professional people including geologists, geophysicists, geochemists, mining engineers, and other experts, many of whom had received grants from MTA for training abroad. The organization carries through projects ranging from the discovery of resources to the preparation of final comprehensive feasibility reports. These reports include careful evaluations of reserves based on extensive drilling, descriptions of pilot plant work demonstrating methods of ore concentration, and planning for production plants.

Most of the area of Turkey has been subjected to a series of tectonic events which have left very complex structures but also substantial mineral resources. Turkish geologists have produced good maps of their country and in the process have identified many exploitable occurrences. In recent years, geophysical methods have been particularly helpful. Airborne surveys have led to discovery of an iron ore deposit sufficient to meet the nation's needs for a generation. Laboratory and pilot plant studies have shown that the ore can be readily concentrated by magnetic separation. Airborne radiation measurements have also led to discovery of a large phosphate deposit, which will soon be providing all of Turkey's requirements.

The laboratories of MTA have made a significant contribution to solving local energy problems through development of a process that upgrades the quality of lignite, which is the country's largest fossil fuel resource. This dusty fuel has a relatively low energy content of about 3100 kcal/kg and a rather high sulfur content. When burned, the fuel produces fumes and smoke. However, MTA has obtained international patents on a process that produces a smokeless fuel yielding over 5000 kcal/kg and at the same time lowers its sulfur content. To obtain this result, the lignite is briefly heated to 400°C and compressed. Considerable water and most of the organically bound sulfur is thus driven off and the end product is a solid briquette.

A tour of the laboratories at MTA created a mixed impression. Some of the equipment was vintage 1940. Some of the techniques would be regarded in the United States as antiquated. However, there was also a considerable amount of modern equipment. The scientists were busy, absorbed in their work, oblivious to visitors.

Because it has good leadership and because it contributes importantly to meeting national needs, MTA enjoys good support from the government. Funds are provided with a minimum of haggling and Sadrettin Alpan, the director general of MTA, has complete freedom to reallocate funds once a budget is approved. Moreover, in contrast to the situation in the United States, appropriations are approved before the start of a fiscal year.

In its management and integration of research and development activities leading to exploitation of natural resources, MTA has been outstandingly successful. The organization could well serve as a model for other developing countries; even the United States might learn a lesson or two from it.—PHILIP H. ABELSON