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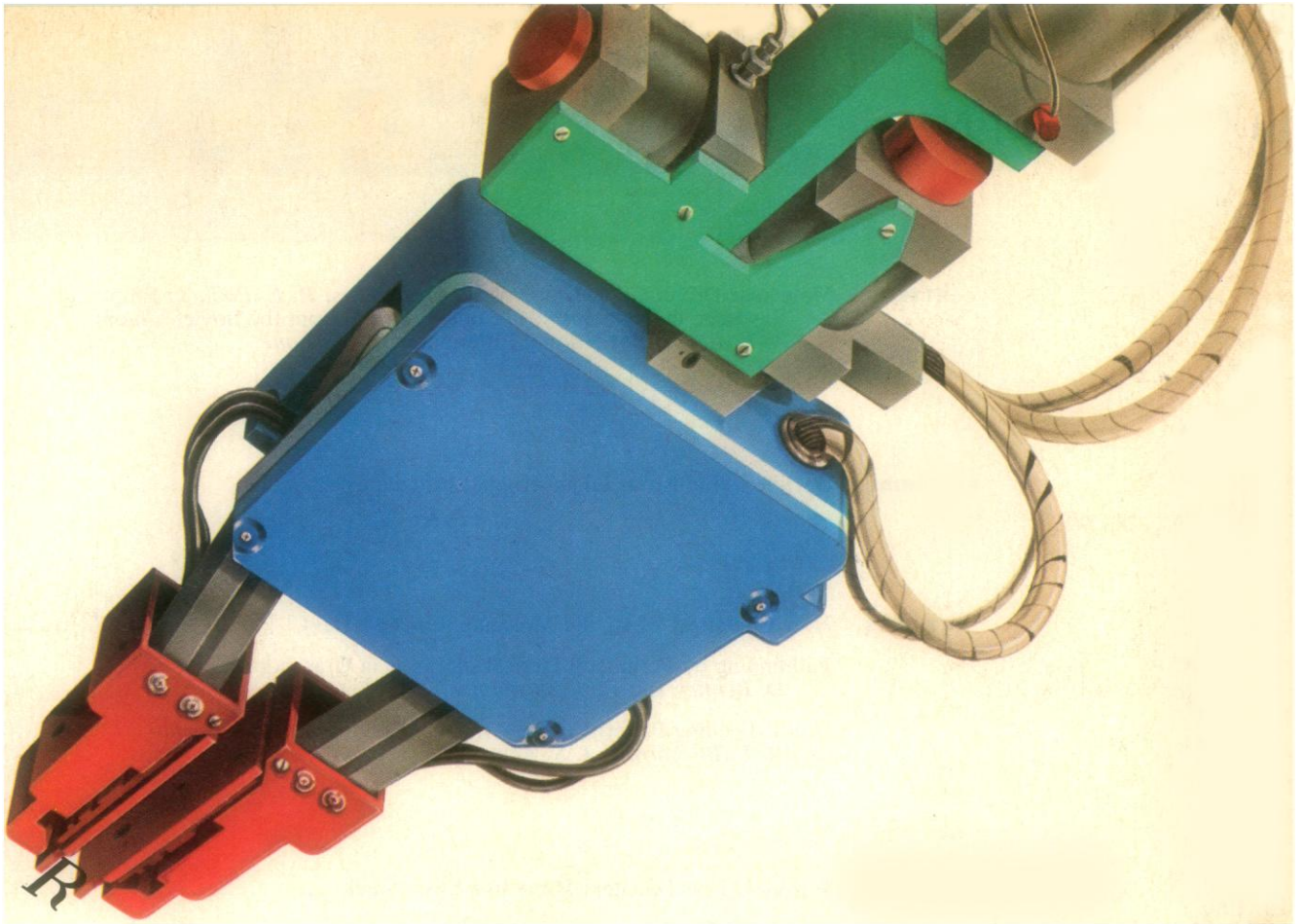
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## COVER

Venus flytrap in its native habitat in the sandy, mineral-poor soil of North Carolina's Green Swamp. The species, which is a candidate for endangered species status, is often sold as a novelty because of its rapid leaf movements which are due to very rapid acid growth. See page 1120. [S. E. Williams, Boyce Thompson Institute for Plant Research, Cornell University, Ithaca, New York 14853]



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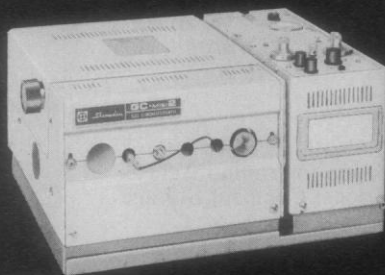
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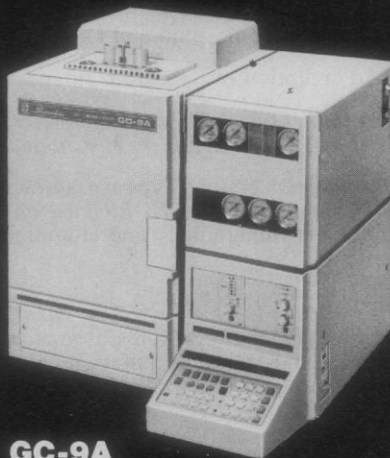
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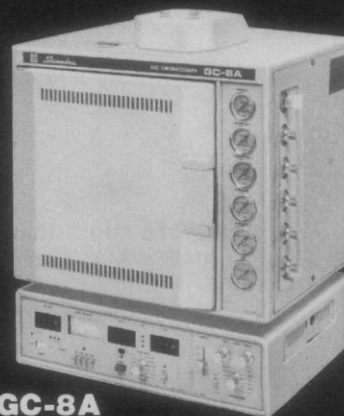
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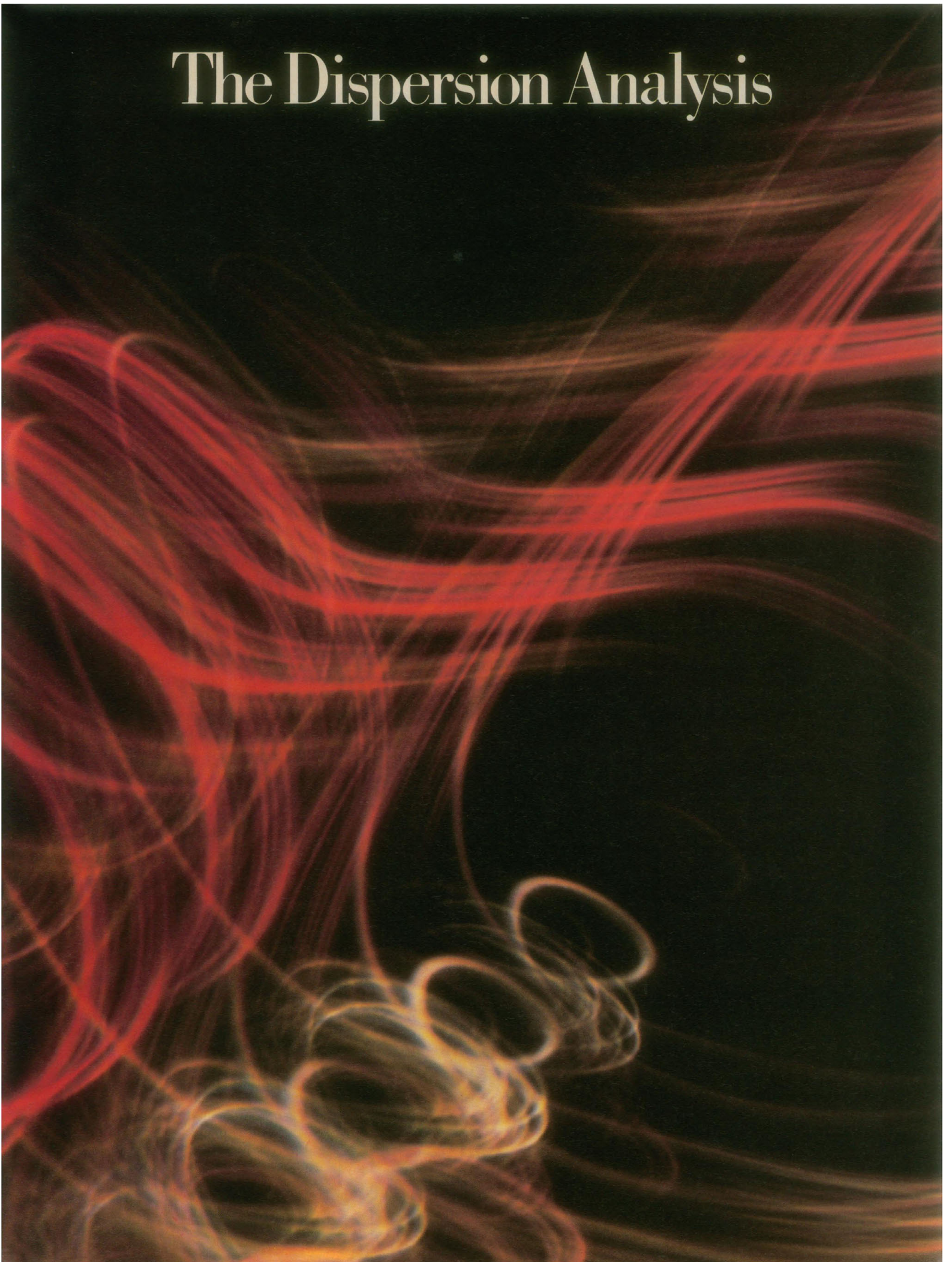
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# The Dispersion Analysis





# The Dispersion Analysis

*Exhaust dispersion near a roadway is influenced by the turbulence and heat generated by moving vehicles. Findings at the General Motors Research Laboratories have provided a new understanding of the dispersion process.*

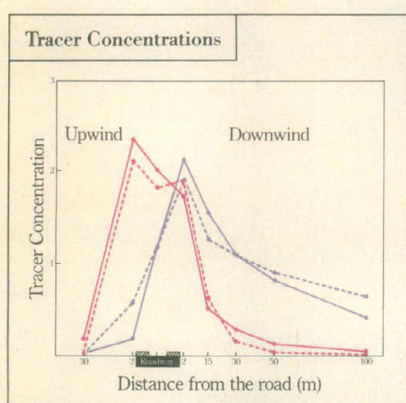
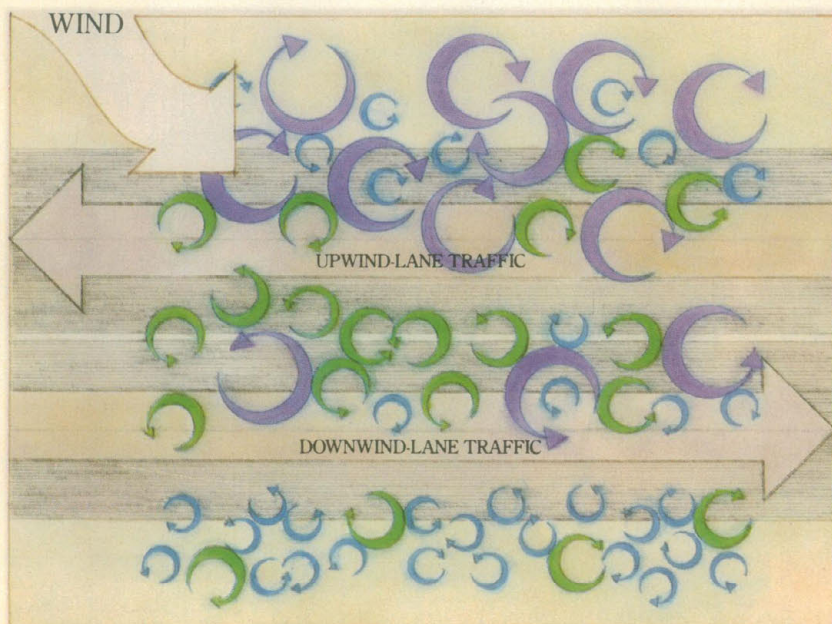


Figure 1: Observed (solid lines) and predicted (dashed lines) tracer concentrations near ground level as a function of distance from the edge of the road. Blue lines indicate the case in which the wind is perpendicular to the road; red lines, when the wind is nearly parallel to the road and opposing the upwind-lane traffic.

Figure 2: This representation of a roadway viewed from above shows the location of large vortices formed by local wind shear when the wind opposes the upwind-lane traffic.



BY USING the conservation-of-mass equation, one can describe the dispersion of gaseous molecules in the atmosphere. The equation includes terms for advection, diffusion, sources and sinks. Advection is the transport of air parcels by the mean wind; diffusion is due mainly to turbulent mixing. But the equation is useful only if we have information about the wind and temperature fields in the atmosphere. Specifically, our ability to predict vehicular exhaust concentrations near a road depends on knowledge of the effects of vehicles on these fields.

The conservation-of-mass equation for the mean concentration of any species,  $C$ , is

$$\frac{\partial C}{\partial t} + \sum_i \frac{\partial (U_i C)}{\partial x_i} = \sum_{i,j} \frac{\partial}{\partial x_i} \left( K_{ij} \frac{\partial C}{\partial x_j} \right) + S_o + S_i$$

Local rate of change      Advection      Diffusion      Sources      Sinks

where  $U_i$  is the mean wind velocity and  $K_{ij}$  is the eddy diffusivity tensor. This equation applies when the length scale of mixing is small compared to that of the variation of the mean concentration. Near a road, this condition is met if the averaging time for the concentration and wind velocity is much longer than the time interval of vehicular passage. For a straight roadway, a long averaging time allows one to assume spatial uniformity in the direction parallel to the road, and to ignore the spatial derivatives in that direction.

The input information for  $K_{ij}$  and the mean crossroad and vertical wind components near a roadway became available as a result of a large-scale experiment conducted by the General Motors Research Laboratories. The experiment has provided an understanding of the influence of moving vehicles on mechanical turbulence and buoyancy near a roadway. Dr. David Chock was responsible for the design of the experiment and the analysis of the data. The experiment, which duplicated a heavily traveled, level roadway, was conducted under meteorological conditions minimizing dispersion.

Moving vehicles affect the mean crossroad and vertical wind components in the following ways. Vehicles act as an obstacle to the mean wind, causing it to slow and move upward as it approaches the vehicles and downward as it leaves the road. In addition, vehicles release heat, which causes a net upward motion. It was established that the increase in the mean vertical wind component due to the exhaust heat was  $(B/U)^{1/2}$ , where  $U$  is the crossroad wind component.



The buoyancy flux,  $B$ , is proportional to the heat emission rate of the vehicles.

Moving vehicles also enhance both turbulence intensity and mixing. To determine how this modifies the eddy diffusivity tensor,  $K_{ij}$ , Dr. Chock invoked a "second-order closure" assumption, which relates eddy diffusivity to Reynolds stresses and the gradients of mean wind velocity and mean temperature. Eddy diffusivity was assumed to be the sum of ambient and traffic contributions. To determine the traffic contribution, the length scale of the traffic-induced turbulence was assumed to be comparable to vehicle height—1.5 m.

USING THE vast data base compiled during the experiment, Dr. Chock was able to specify  $K_{ij}$  and the mean crossroad and vertical wind components, and solve the equation numerically. To test the model, half-hour measurements of a tracer gas were used to map out experimentally the exhaust dispersion under various meteorological conditions. The case where the wind speed is low and the wind direction is nearly perpendicular to the roadway is represented by the blue lines in Figure 1. Both the model and the experiment show the same dispersion pattern. The peak concentration is on the downwind roadside.

When the wind is nearly parallel to the road, the situation is much more complicated. Figure 2 shows that when the wind and traffic flow on the upwind lanes oppose each other, a high shear region occurs immediately upwind of

the first traffic lane. When the wind and traffic are in the same direction, the high shear region occurs in the median of the road. In these high shear regions, large eddies are generated and turbulent mixing is intense. The red lines in Figure 1 show a comparison of the model's predictions with the tracer data for the case illustrated by Figure 2. Notice that the peak concentration can actually occur on the upwind roadside, due to the exhaust transport by these large eddies. Dr. Chock's model is the first to predict this occurrence.

Under all combinations of wind speeds and directions, the predictions based on the model compare favorably with the measured tracer concentrations. There is little systematic bias with respect to wind direction.

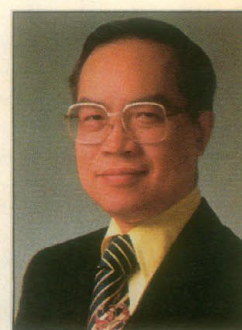
"In light of this new model, exhaust dispersion near a roadway can now be predicted with reliability," says Dr. Chock. "This is of importance for environmentally sound road planning, and opens the door to the investigation of dispersion on city streets, where the presence of tall structures introduces even further complexity."

## THE MAN BEHIND THE WORK

Dr. David Chock is a Senior Staff Research Scientist in the Environmental Science Department at the General Motors Research Laboratories.

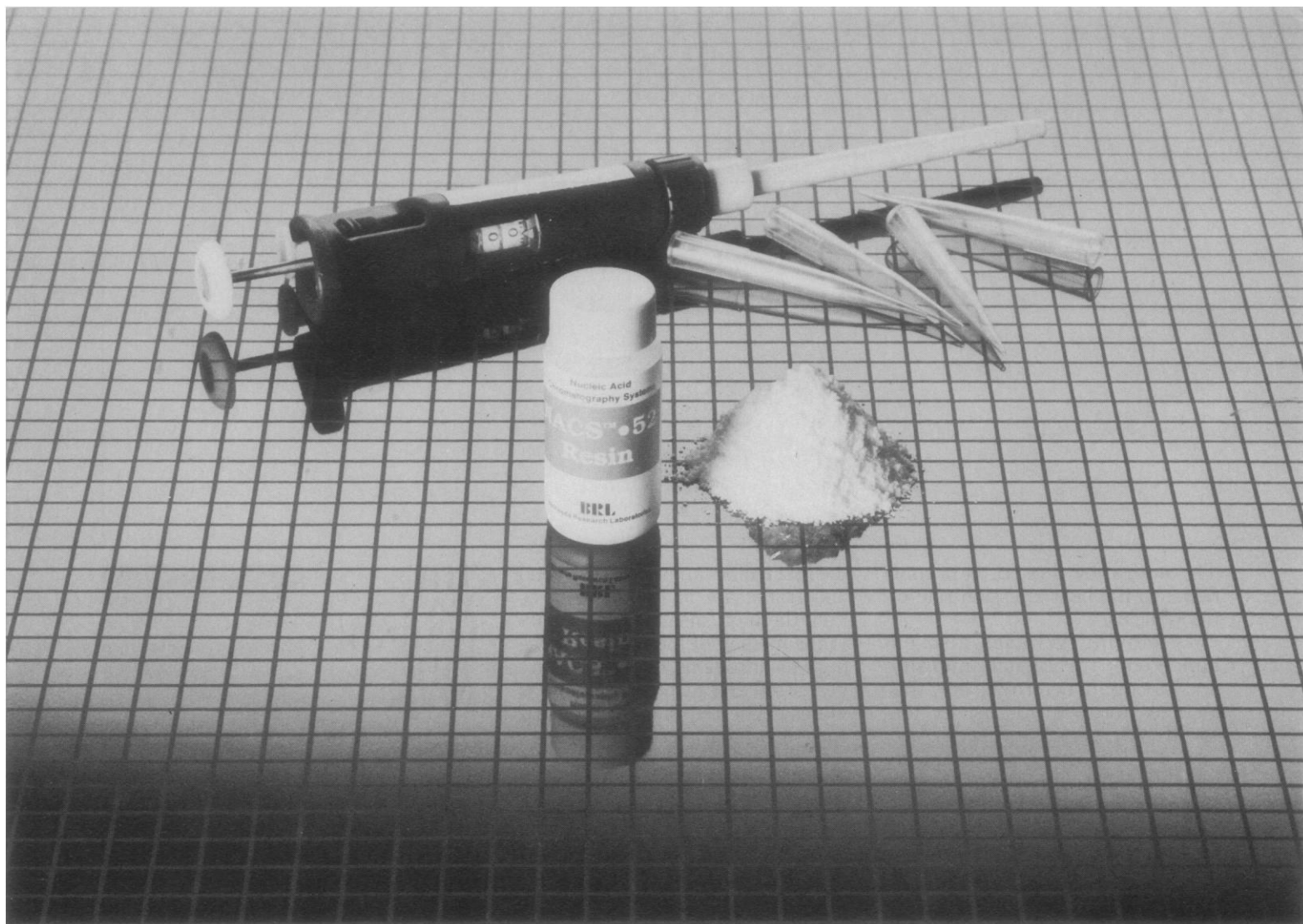
Dr. Chock received his Ph.D. in Chemical Physics from the University of Chicago. His thesis concerned the quantum mechanics of molecules and molecular crystals. As a Postdoctoral Fellow at the Free University of Brussels, he did research work on the dynamics of critical phenomena. He did additional postdoctoral work in the fields of solid-state physics and fluid dynamics.

Dr. Chock joined the corporation in 1972. He is leader of the GM atmospheric modeling group. His current research interests include the phenomena of atmospheric transport and reactions, and the statistical study of time-series data.



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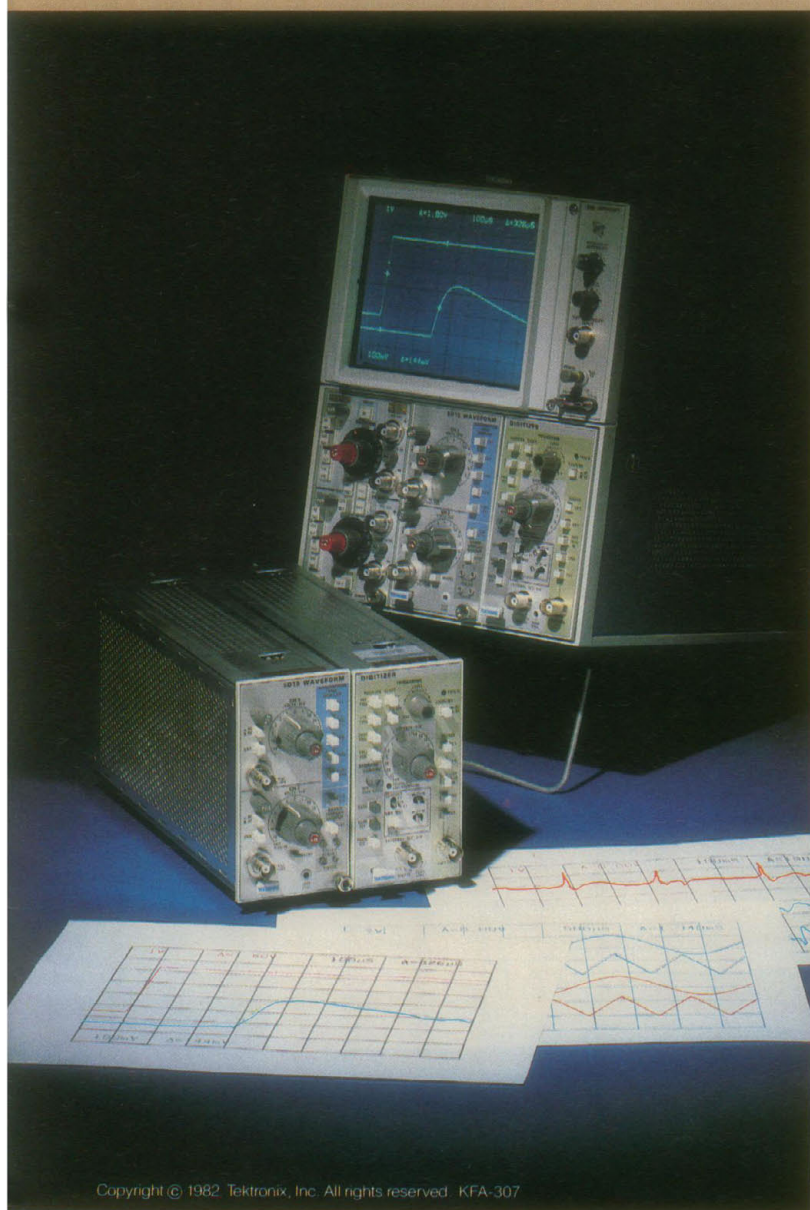
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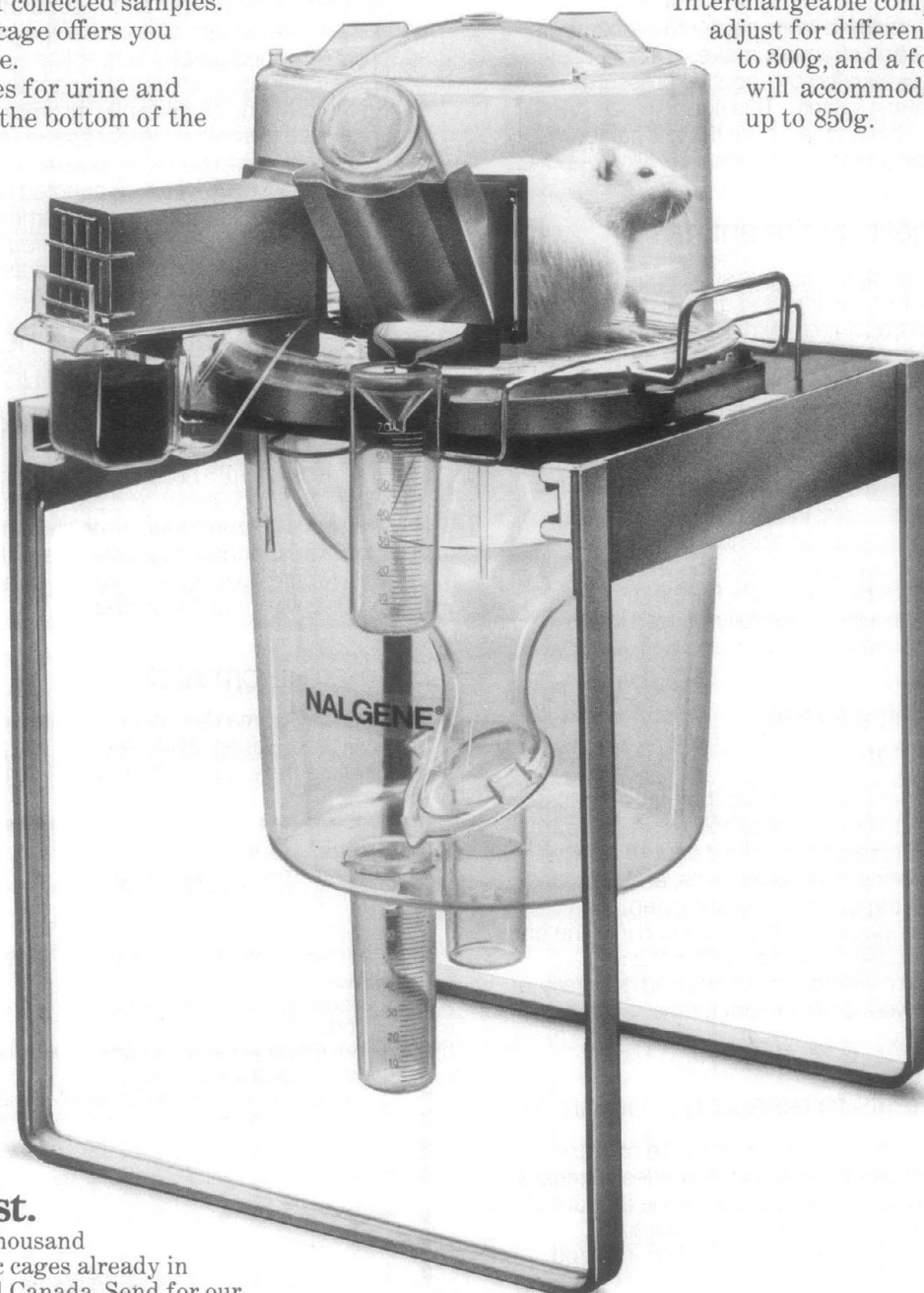
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# The Ventilated Animal Rack:

Some day soon most research animals, personnel, and research programs will be protected this way.\*

## What is a "Ventilated Animal Rack"?

It is a portable, totally enclosed animal rack with four separate, independent, isolated-from-each-other chambers. Low velocity air enters each chamber, makes a single pass over the cages, and is exhausted by negative pressure directly to the main exhaust system. This special rack (VR-1) most effectively isolates the animals from the animal room... and the research personnel from the animals.

## What are the benefits to the animals?

There are many. Cross-contamination is substantially decreased because air from an infected animal goes to the exhaust system with an absolute minimal exposure of the other animals. Animal stress is also significantly reduced: the enclosed environment is quiet; drafts and thermal and humidity fluctuations are greatly minimized; and animals can be easily observed without inducing stress. The success of this environment is attested to by the fact that the total number of animals born to a species that breeds poorly (DBA/2J mice) is increased and the percent survival is also appreciably higher. Additional evidence: judging by acceleration of weight gain, newly arrived animals housed in this system become acclimated more rapidly. Further evidence? Even multiple species can be successfully housed in the same rack.

## What are the benefits to the research workers?

Since the air in the rack is exhausted into the main exhaust system and does *not* re-enter the animal room itself, research workers are effectively isolated from animal dander or other allergens, odor, pheromones, microorganisms, and food and bedding dust. Even with the doors of the unit open, the direction of air flow tends to be *from* the room and *into* the unit which helps to contain contaminated air *within* the unit. Result: virtual elimination of allergic reactions and generally, a cleaner, safer, odor-free work environment for the research people.

## What are the benefits to research programs?

Because this system greatly reduces the chance of cross-contamination, and because it provides a much less stressful environment generally (e.g., it tends to reduce the amount of animal handling required), the chances of jeopardizing expensive research programs are substantially minimized.

## Are there other benefits?

The air velocity is variable and is separately adjustable for *each* shelf. The system offers a choice of bottle watering or a specially designed upfeed serpentine automatic watering configuration that eliminates stagnant water, permits flushing during the day, and significantly minimizes contamination. This rack also permits excellent space utilization since multiple species can be safely housed in the same room. Cleaning is easy; VR-1 can be handled by most standard rack washers. The unit is quiet. And, in summary, it is a most effective isolation system *that can actually divide a room into multiple separate, isolated environments.*

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\*Many of these systems are already installed in major research institutions... and conversion to these ventilated animal racks is accelerating.



The VR-1 is the subject of one or more pending patents.

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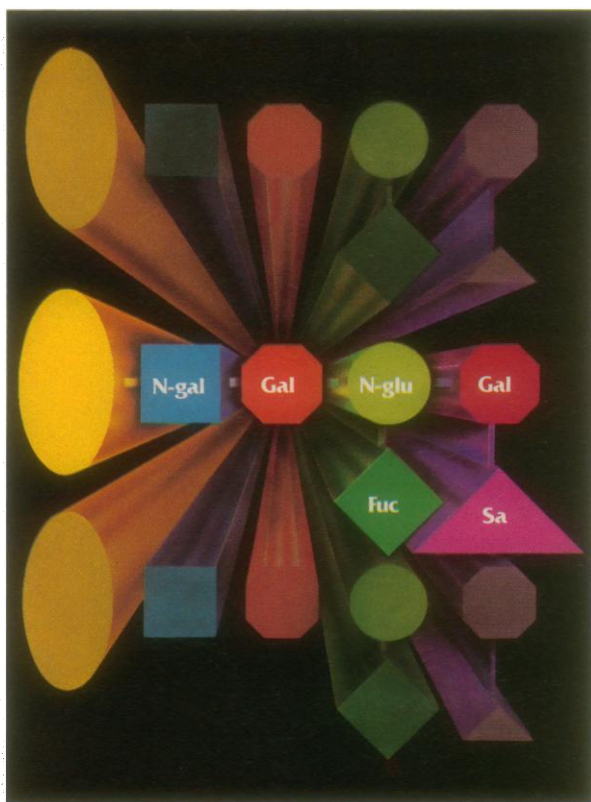
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Here's what men and women aged 35, for example, now pay for 5-Year Renewable Term policies of different amounts:

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Premium per \$1,000	\$2.53	\$1.69	\$1.69	\$1.69	\$1.52
<b>Issued to women aged 35</b>					
First-year premium	\$110.25	\$147.00	\$220.50	\$294.00	\$330.75
Premium per \$1,000	\$2.20	\$1.47	\$1.47	\$1.47	\$1.32

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**To receive personal illustrations** of new MOD ONE policies, mail the coupon, or phone the TIAA Life Insurance Advisory Center Toll Free at 800-223-1200 (in New York, call collect 212-490-9000). No one will call on you as a result of your inquiry.

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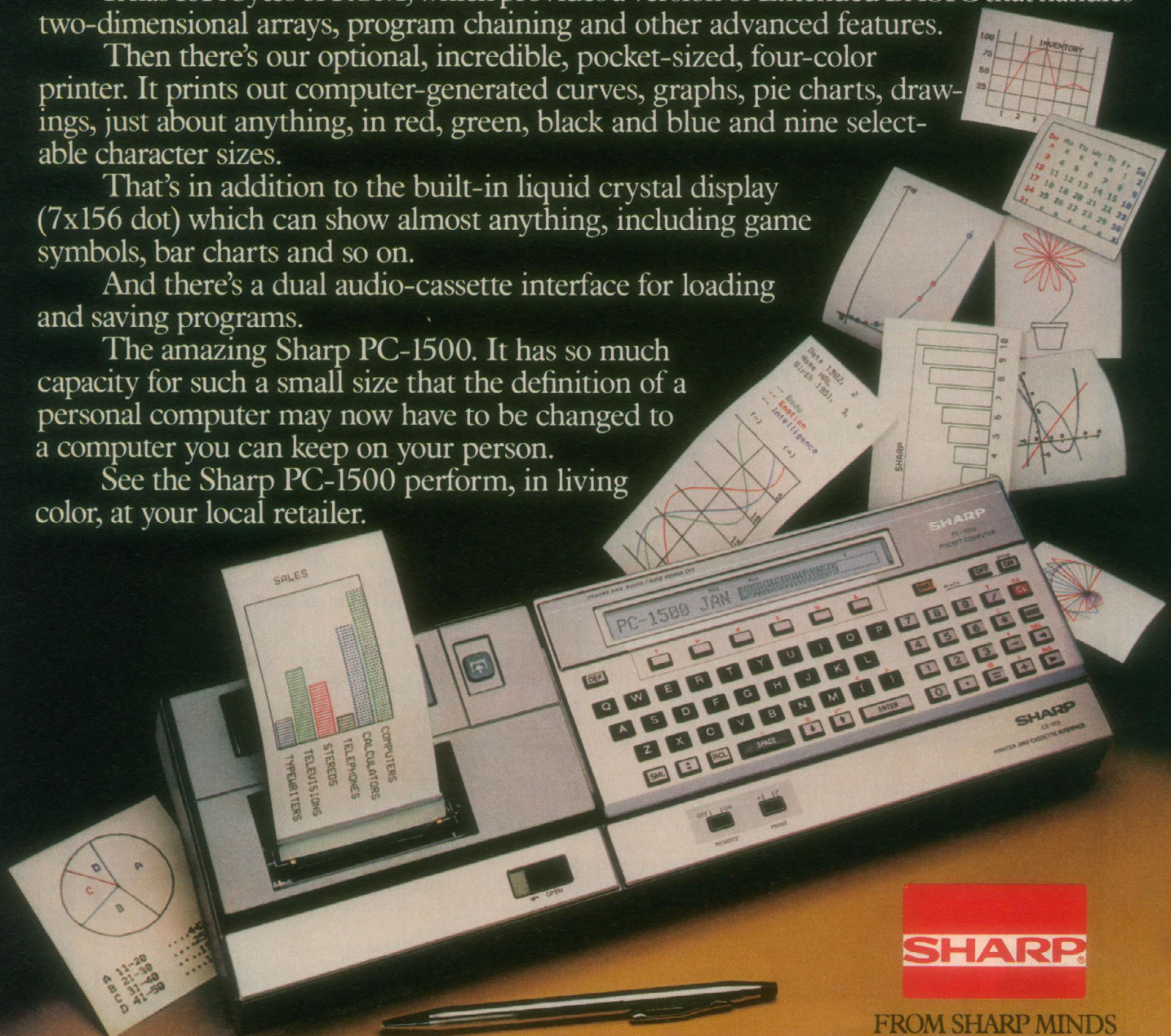
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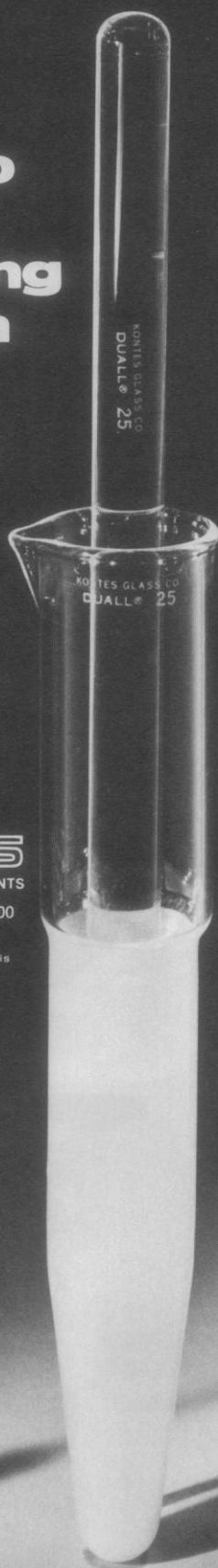
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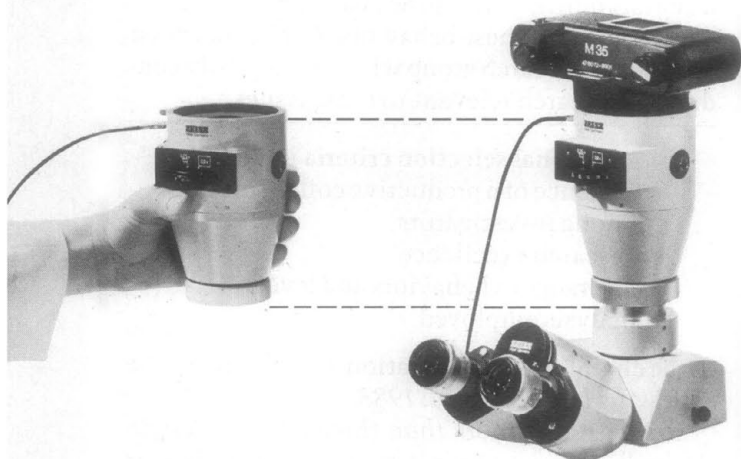
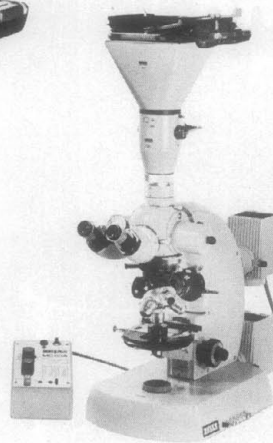
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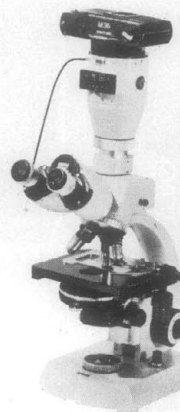
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## Decline in Industrial Engineering

As president of a university with a school of engineering and as a director of large manufacturing corporations, I am more and more convinced that the steady decline of some of our major industries, such as steel, automobiles, energy, and mass transportation, is closely related to our lack of competitiveness in engineering in these fields.

Excessively high wages, union work rules, and unreasonable government regulations are usually offered as reasons for the difficulties of these industries. I argue that the quality of management and the quality of engineering are at the root of some of our most serious problems, at least in the crucial fields mentioned above. An excessive proportion of executives are products of business schools and are not technically oriented, and an excessive proportion of our engineers are inadequately trained.

These inadequacies in training begin in our high schools, where the teaching of mathematics and physical sciences is degenerating. Low salaries and low prestige are driving qualified teachers, particularly science teachers, into other fields.

In West Germany, France, Switzerland, Japan, and the Soviet Union, students typically arrive at engineering schools with a solid background in advanced calculus and theoretical physics. They usually have 7 years of postsecondary education before being hired by industry. In the United States, students are hired after only 4 years of college, the first year of which is often remedial, to make up for the deficiencies of our secondary school system. This provides at best only 2 years of training for engineering.

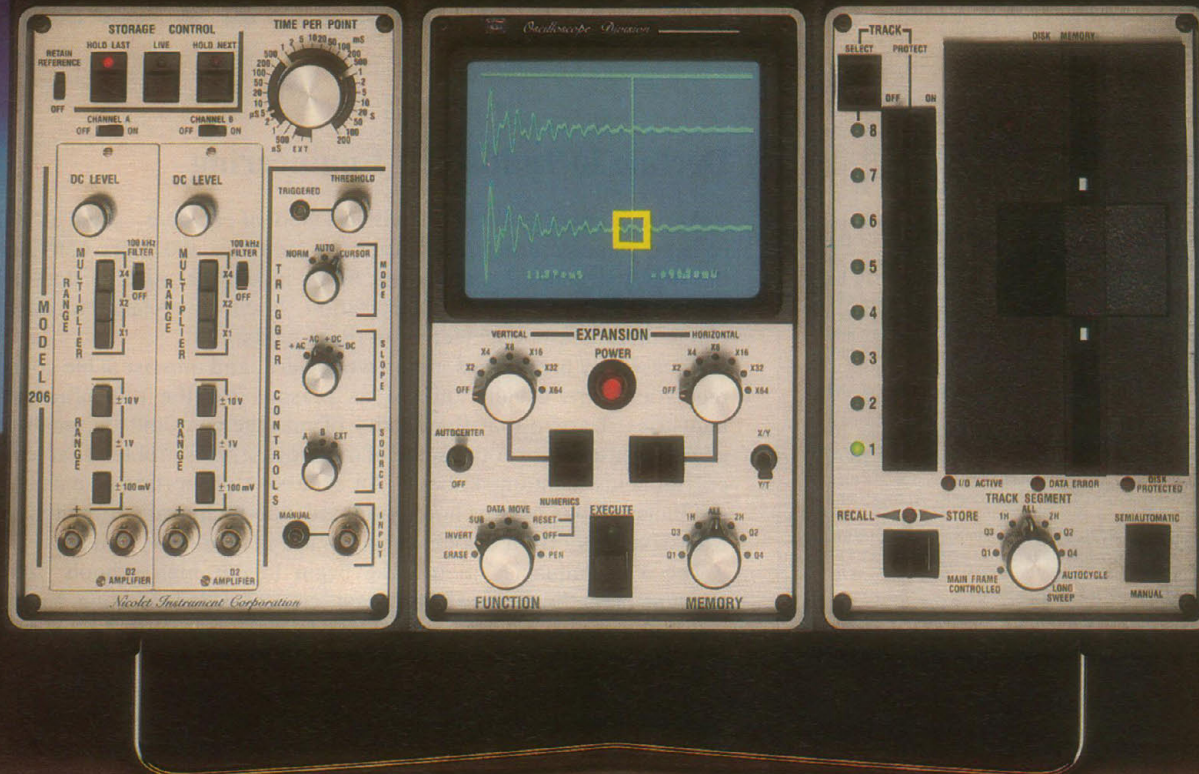
The appetite of industry for engineers at present is such that there is relatively little financial reward in spending a fifth year getting a master's degree or going on to a Ph.D. in engineering. As a consequence, industry receives few people with an advanced education in engineering and the supply of faculty for engineering schools is becoming more and more precarious. While a great deal of educational effort is expended by companies to train recently graduated engineers for their first job, this does not make up for the fact that continuing education for engineers is primitive as compared, for example, to the postgraduate education that hospitals, universities, and medical associations provide for health professionals.

The effects of these shortcomings are already visible. Our nuclear plants are poorly designed, and it is in large part because of this (not just regulatory changes) that there are more and more expensive change-orders. Because relatively little attention has been paid in this country to the probes upon which the cybernetic systems in the steel industry should be based, steel companies are arranging for Japanese engineers to install the process controls that they have been unable to plan internally. Domestic companies seem incapable of engineering such relatively simple projects as subway cars; both New York and San Francisco have selected French cars for their systems. Foreign automobiles, particularly Japanese ones, are preferred by a large part of our population, on the basis not of price but of better design.

At the same time, an Administration that wants to "reindustrialize America" and "rearm America" is eliminating all funds for engineering education and most funds for science education from the budget of the National Science Foundation. The small instrumentation program launched by the Department of Defense and the modest gift program from industry made possible by the new tax laws are not satisfactory substitutes.

We need to restructure our secondary school science curriculum and make it possible to support engineering schools for a fifth year of training. We need support for training and salary supplementation for mathematics and physics teachers in high schools. We need equipment for both high schools and schools of engineering. Only a massive effort to improve science education in our high schools and engineering education in our universities can keep our young people competitive with young engineers in other advanced industrialized nations.—JEAN MAYER, *President, Tufts University, Medford, Massachusetts 02155*

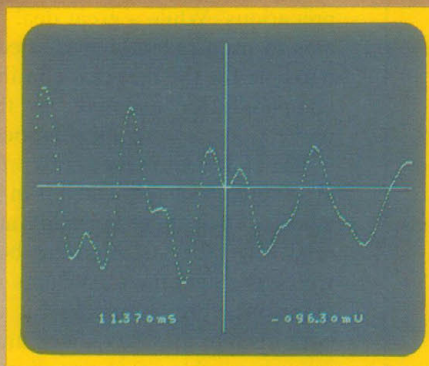




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