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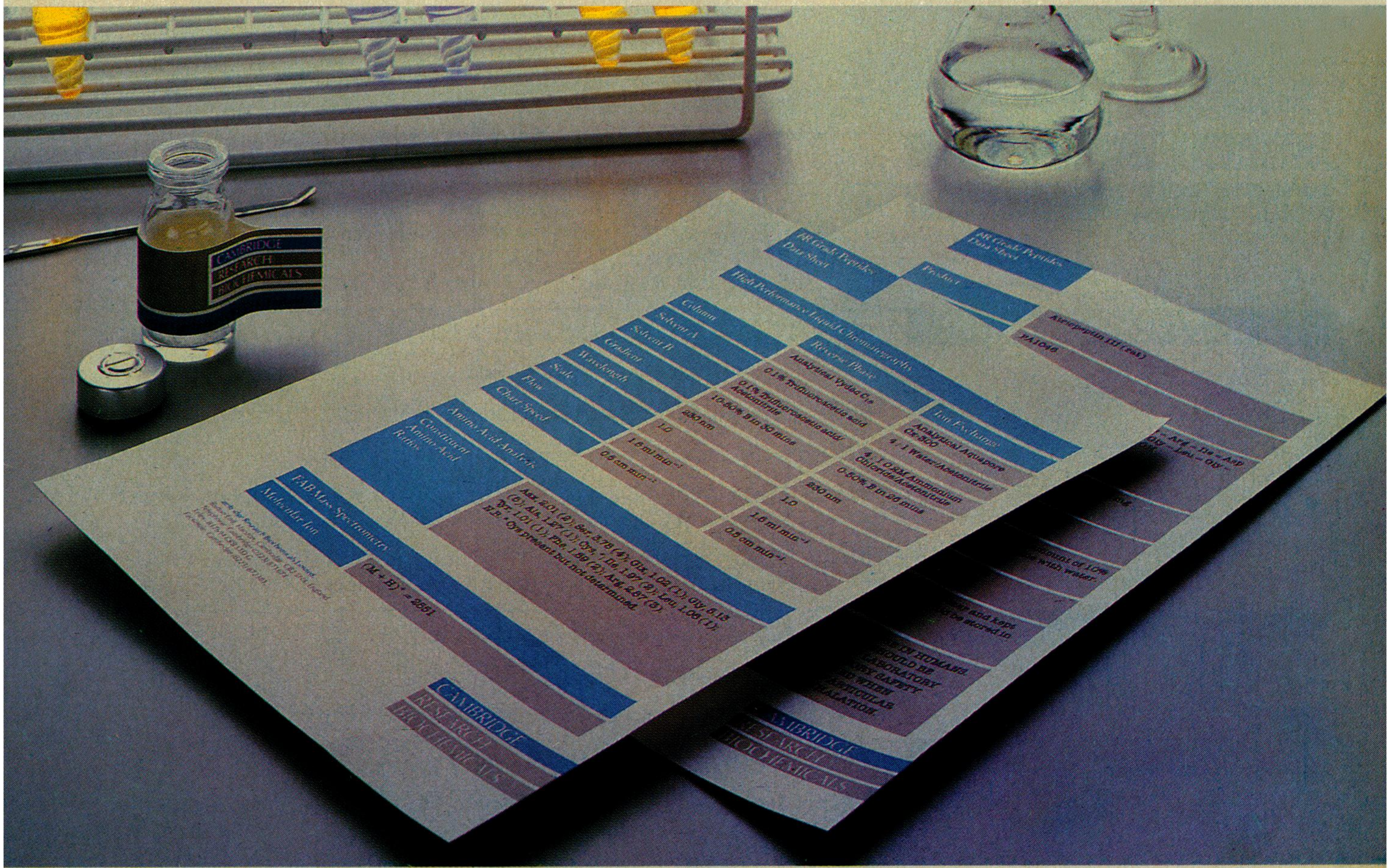

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COVER Footprint with skin impressions of a small (1 meter) Late Triassic lizard-like form (probably spenodontid) that walked along the shores of a rising lake. The lake level rose and fell during the early Mesozoic in response to orbital forcing of climate. See page 842. [Paul E. Olsen, Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY 10964]

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This Week in SCIENCE

Third World debt

ENORMOUS debts face many Third World countries (page 836). The debts have developed from a combination of imprudent borrowing policies (with money used for open-ended consumption, loss in capital flight, or spent to finance budget deficits rather than to produce a return through investment), imprudent lending by commercial banks that paid insufficient attention to the riskiness of the loans they made, and generally unfavorable world economic conditions. All parties that contributed to creating the predicament share in the responsibility to rectify it; all are cooperating because the situation threatens to create not only economic but also political instability worldwide. Dornbusch and Fischer identify borrowing and lending mistakes and mistakes in judgment that have contributed to the current debt crisis in Latin America and Third World countries elsewhere, describe the recent U.S. plan (the Baker plan) for dealing with the situation, and suggest factors to be considered for solving problems of both borrowers and lenders.

Earth's climate and orbit

FORCES that perturb the earth's orbit—the precession of the equinoxes, the obliquity cycle, and the eccentricity cycle—have shown little alteration in periodicity for 200 million years (page 842). Through their effects on the earth's orbit, such forces have changed the seasonal and geographic distribution of sunlight that reaches the earth and thus have altered its climate. Olsen studied exposed Triassic and Jurassic period sediments in eastern North America in 13 basins from Nova Scotia to North Carolina (cover); the formations contain records of changing water levels in large lakes, their salinity, sediment composition, and other clues to past precipitation, cloud cover, and, ultimately, climate in the early Mesozoic. The periodicities recorded in the sedimentary sequences are similar to those found in more recent (Quaternary) geologic records; these sequences, in turn, reflect the predicted periodicities of the celestial forces. How such forces affected the ancient Triassic and Jurassic climates (the orbital theory of climate change) can only be speculated upon. Those were times when the earth was ice-free, and orbitally forced changes in heating intensity would not have melted glaciers or icy seas. Such forces may, however, have driven monsoonal winds that altered precipitation patterns and other factors affecting the earth's climate.

Omega loops

COMPACT loops shaped like the Greek letter omega (Ω) make up a new category of amino acid assemblages in globular proteins (page 849). Classical protein secondary structures have included α-helices, β-sheets, reverse turns, and random coils. Leszczynski and Rose established three criteria for defining loops: they contain 6 to 16 amino acids, they lack regular secondary structures, and the distance across the gap where the loop necks in must be less than 10 angstroms. Evaluation of 67 proteins of known structure revealed 270 loops; only six of the proteins had no loop at all. Hydrophilic amino acids with short side chains were favored in the loops, and most loops were situated on the protein's surface, where they may contribute to the antigenicity and biological activity of the protein molecule. Omega loops are likely to be valuable structures for clipping and swapping in bioengineering experiments; such clipping and swapping may be a natural process that has, through evolution, made possible the conservation of structure and function in related proteins.

Bright future for gene expression studies

A new bioengineering technique has been developed by Ow *et al.* for illuminating details of gene expression in plants and plant cells (page 856). The gene for the enzyme luciferase, which causes fireflies to glow [by oxidation of its substrate luciferin in the presence of adenosine triphosphate (ATP)] has been inserted into plant cells. When luciferin and ATP are added to extracts of cultured carrot cells containing the gene, a light flash can be recorded; when whole tobacco plants with the gene are watered with luciferin, they light up. Roots, stems, and leaves of the plants express the luciferase gene; it then serves as a reporter of the plant gene regulatory signals to which it is linked. Because this is a noninvasive technique, transgenic plants and plant cells can be monitored during development for gene activation, ATP production, and other cellular events that affect the enzymatic reaction. The light output can be recorded on photographic or x-ray film, measured with luminometers, or watched with video equipment.

Karyoplasmic streaming

TIME-LAPSE studies indicate that the nucleolus and other substructures in the nucleus of a cell are in continuous motion, with occasional stops and reversals (page 863). The "karyoplasmic streaming," which mimics in the nucleus the "cytoplasmic streaming" that takes place in the rest of the cell, has been clocked in previous studies at rates as fast as 1 revolution per minute. When the nuclei of neurons were stained in vitro with a fluorescent dye called DAPI, tandem rotation of nucleoli and chromatin domains was observed, first in two dimensions and then in three dimensions; the movements of nuclear substructures were not coordinated with movements of nearby cytoplasmic structures. Since karyoplasmic streaming is not obligately coupled to the sorting of chromosomes preparatory to cell division (the neurons studied were developmentally arrested in interphase), De Boni and Mintz suggest that the streaming may serve to move chromatin domains to pores in the nuclear membrane where their genes may then be actively expressed.

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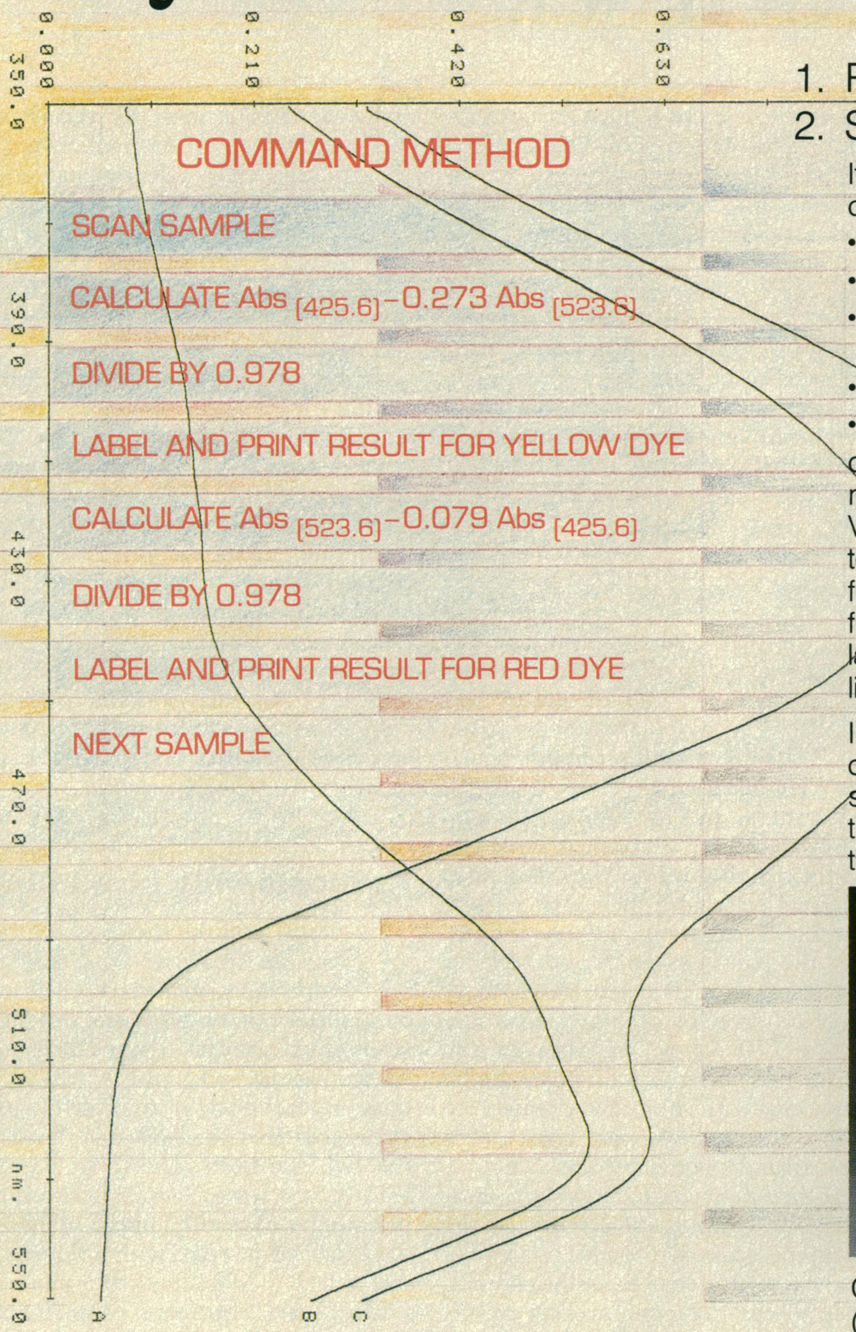


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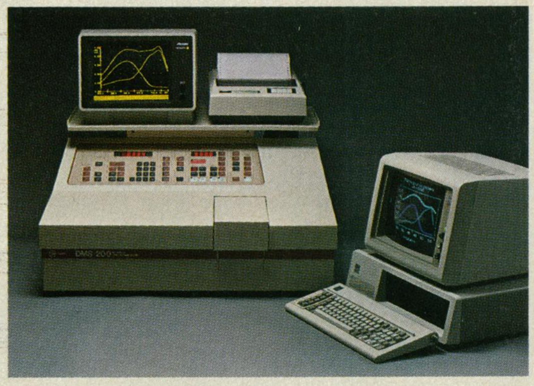

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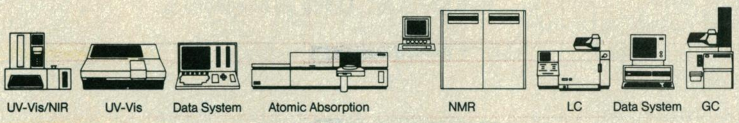

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SCIENCE

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The Fifth Decade

The 40th anniversary of the Office of Naval Research is an occasion for congratulations and presents an opportunity for estimating prospects for government-supported research and development in coming years. The ONR, to borrow from the language of summitry, served as the base camp from whence government set out to become the nation's patron of fundamental research. The flexibility, outreach, and breadth of vision the ONR contributed to postwar science serves as a striking model in the new context of today's challenges.

Few would have thought, in the interval between the end of the war and the onset of superpower tensions, that government's stakes in research and development would reach the present scale. In the mid-1960's a spokesman for the Bureau of the Budget would venture to tell a meeting of research administrators that because in the previous 5 years federal funds had doubled to the level of $15 billion, the era of fast growth was over. It took another 14 years, but the total doubled again. Now, in just the past 6 years, we have had the third doubling. Even after adjusting for inflation, the acceleration of support is striking.

Do the cards foretell a fourth doubling—perhaps before the new century sets in? Given the composition of the research and development agenda, loaded as it is in favor of defense and space, no one can say that the potential is not there. Aside from pressures for defense-related development, the basic sciences are pregnant with opportunities awaiting funding, as the flow of reports from the National Research Council demonstrates. But funds are not distributed evenly over the spectrum of federally financed research and development, a problem reflected in the current appropriation for the National Science Foundation with its clutter of floors and ceilings attesting to the politics of science.

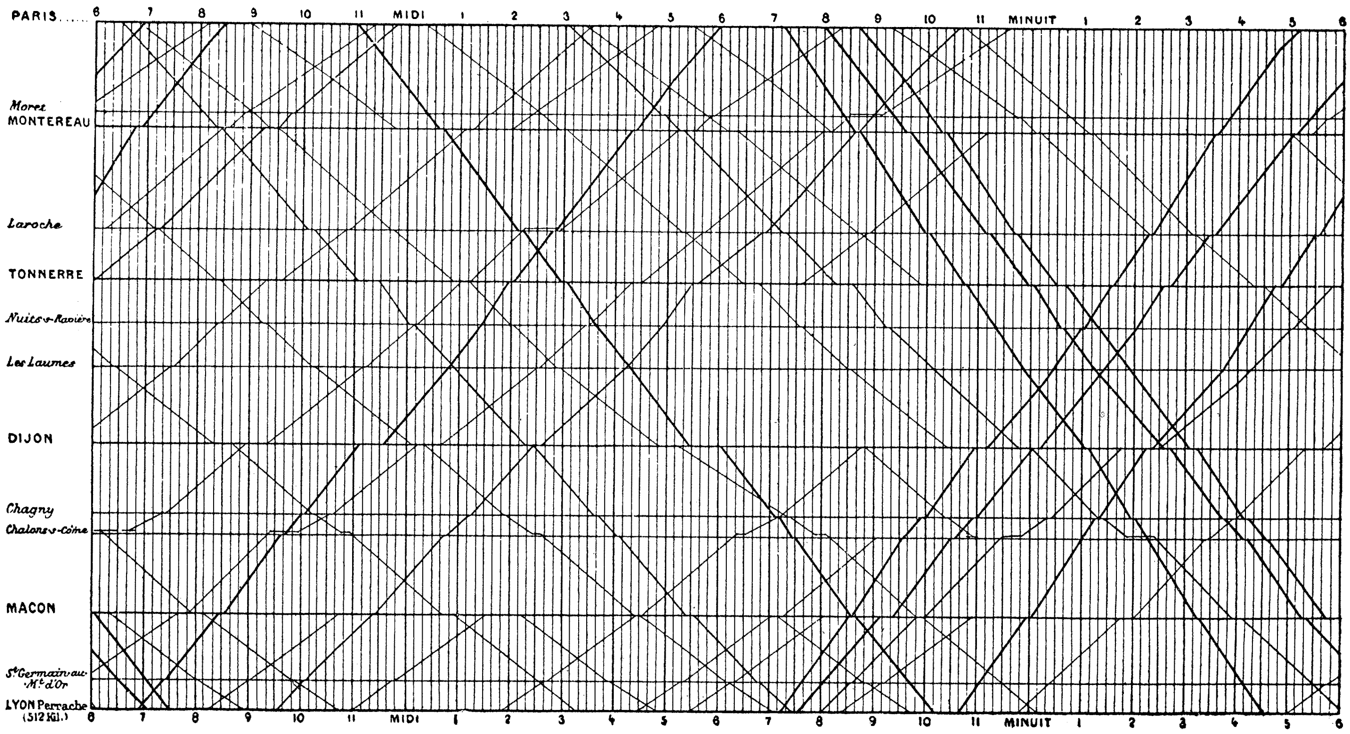
Even in a moderate growth scenario, there always are winners and losers, but when we are in a cycle in which discretionary spending is to be minimized while preemptive priorities are maximized, queuing difficulties are likely to be very severe. Whether, indeed, another doubling from a high base of roughly $60 billion is even desirable turns on whether the productive capacity of existing research assets can be stretched that much, given the prolonged reinvestment drought in science education and research infrastructure. It would be very rash public policy to chase the elusive imp of "competitiveness" with a funding frenzy that takes for granted the sufficiency and resiliency of the research and development system's reserve capacities.

If in the fifth postwar decade science is confronted with a version of limits to growth, save for privileged areas of research and development as defined on government's terms, there is a lot to think about. With less support than will be needed to advance all fields of research, the unity of science can give way to contention between and among disciplines, each looking out for itself regardless of the cost to science as a whole. It would not be a pretty scene. A more mature behavior, reflecting the stages of growth through which science has come, would involve the convergence of disciplines and their organizations in a process of rationalization of ends and means in the presence of limits.

It would stretch credibility to claim that science has the institutional arrangements for such an undertaking, although they could be assembled with enough leadership and hard work. The issues to be addressed thereafter are both difficult and interrelated. They bear on the balance between big and small science, native pride and internationalization, targeting strategies and the free play of opportunities, distributive equity and concentration, and the workability of new funding mechanisms, to give only a partial listing. If it all sounds troublesome, and it is, the case would be worse if the complexities of rationalization were left entirely to government and its responses to the dictates of budgetary pragmatism.

The core features of the long partnership of science with government are still substantially in place, thanks in large measure to the enduring work done long ago by farsighted leaders at ONR. Now, as the growth capacity of science sights oncoming constraints on public investment, the fifth decade will put to test the partnership's abilities to address, through a workable institutional process, the emerging dilemmas of choice.

—WILLIAM D. CAREY



This remarkable graphical train schedule, drawn in 1885 by the French scientist E. J. Marey, shows the trains running between Paris and Lyon, with intermediate stops. For example, the first train of the day leaves Paris at 6:30 am (upper left corner) and arrives in Lyon 13 hours later. (The modern high-speed train now makes the journey in 3 hours.) The diagonals moving from upper left to lower right show all trains going from Paris down to Lyon.

Trains going from Lyon to Paris are indicated by diagonals running from the lower left to the upper right. Steeper lines indicate faster trains. When a train stops at a station, the line is horizontal during the time of the stop. When two trains pass one another, the lines on the graphical train schedule cross. Graphical schedules are currently used in Japan for managing the day-to-day operations of the *Shinkansen* (the bullet train) and by New Jersey Transit.

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oped from the few survivors of a mass selection lost their resistance (*4*).

In the field, the level of selection declines from 100% to 0% over the margin of a treated area, and here the changes of gene frequency are a function of the selection pressure. Gene flow into the selected area allows the resistant factors to be assembled into the resistant strain.

The response to directed selection depends not only on the change of frequency of the resistant factors but also on the response to selection for a genetic background required for fitness of the resistant strain (*5*).

W. D. McEnroe
Suburban Experiment Station,
University of Massachusetts–Amherst,
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Response: We agree with Tabashnik that the optimal dose depends on a number of factors, as emphasized in several places in our article. We did not imply that a low dose applied to a population with incipient resistance will always aggravate the problem.

Our point is that the optimal dose and use patterns vary widely; there are no simple solutions, and populations with suspected incipient resistance create a dilemma, particularly in determining the dose. The major problem here is, as we pointed out, that it is not possible to detect incipient resistance development with currently available technology; therefore, computer models are not yet of much *practical* help.

We do not advocate the use of high doses in any situations, but instead, in the article, recommended the maintenance of refugia (Tabashnik's points i and ii), genetic studies to characterize the inheritance of the resistance allele (Tabashnik's point iii), and intensive monitoring of resistance gene frequencies (Tabashnik's point iv) to make the best judgment.

We agree with Tabashnik that the use of a high insecticide dose most likely will cause more problems than it can solve, presents serious risks for undesirable side effects, and runs counter to integrated and any other sensible use of insecticides.

Therefore, we think the only way the phrase Tabashnik quotes ("exposing a population with incipient resistance to a low insecticide dose leads to rapid fixation of resistance. . .") can be misconstrued as a recommendation to use a high dose of insecticide is to read it out of its context.

McEnroe makes the interesting and valid point that resistance development depends not only on the gene (allele) directly responsible for a certain resistance mechanism but also on genetic fitness factors or a "genetic background required for fitness."

We did not mention this in our article because not much can be said about this phenomenon in relation to resistance in agricultural insects.

McEnroe's point deserves significantly more attention than has been afforded it so far.

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"Mazel Tov" Usage

I would like to respond to Stephen A. Ockner's comment (Letters, 17 Oct., p. 261) about "Mazel tov."

The current use of the term "Mazel tov" certainly does mean "congratulations," rather than "good luck." This is not, however, its original meaning. The Yiddish term "mazel," stems from the Hebrew "mazal," which means "constellation." Tov just means "good." The direct translation of "mazel tov" is therefore, "A good constellation!" The idiom originated from the astrological interests of the Jews in ancient Israel, which are well known from surviving mosaics on floors of certain synagogue ruins. In less idiomatic terms, when an ancient Israeli said, "Mazel tov!" he was wishing a good astrological influence for the recipient of his statement. This can be loosely termed, "Good luck!" The usage of the idiom, however, can also follow the event for which luck was being wished. Rather than, "May you be blessed by a good constellation," it becomes, "You must have been blessed by a good constellation," or "Congratulations!" Either way, it comes out "Mazel tov."

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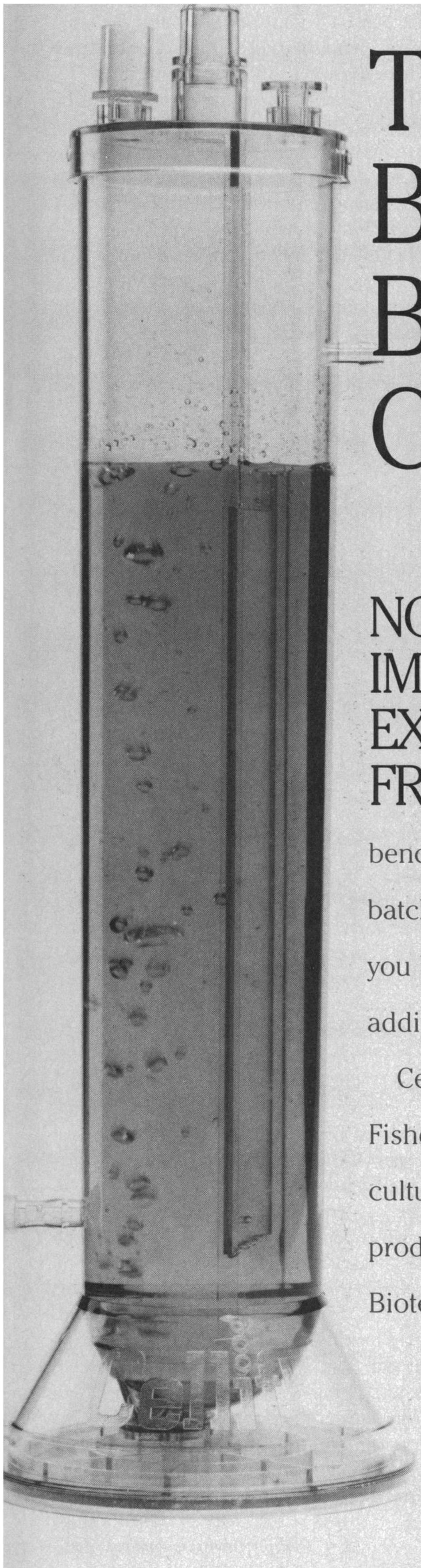

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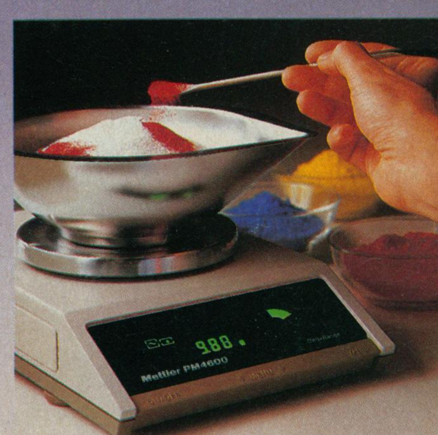

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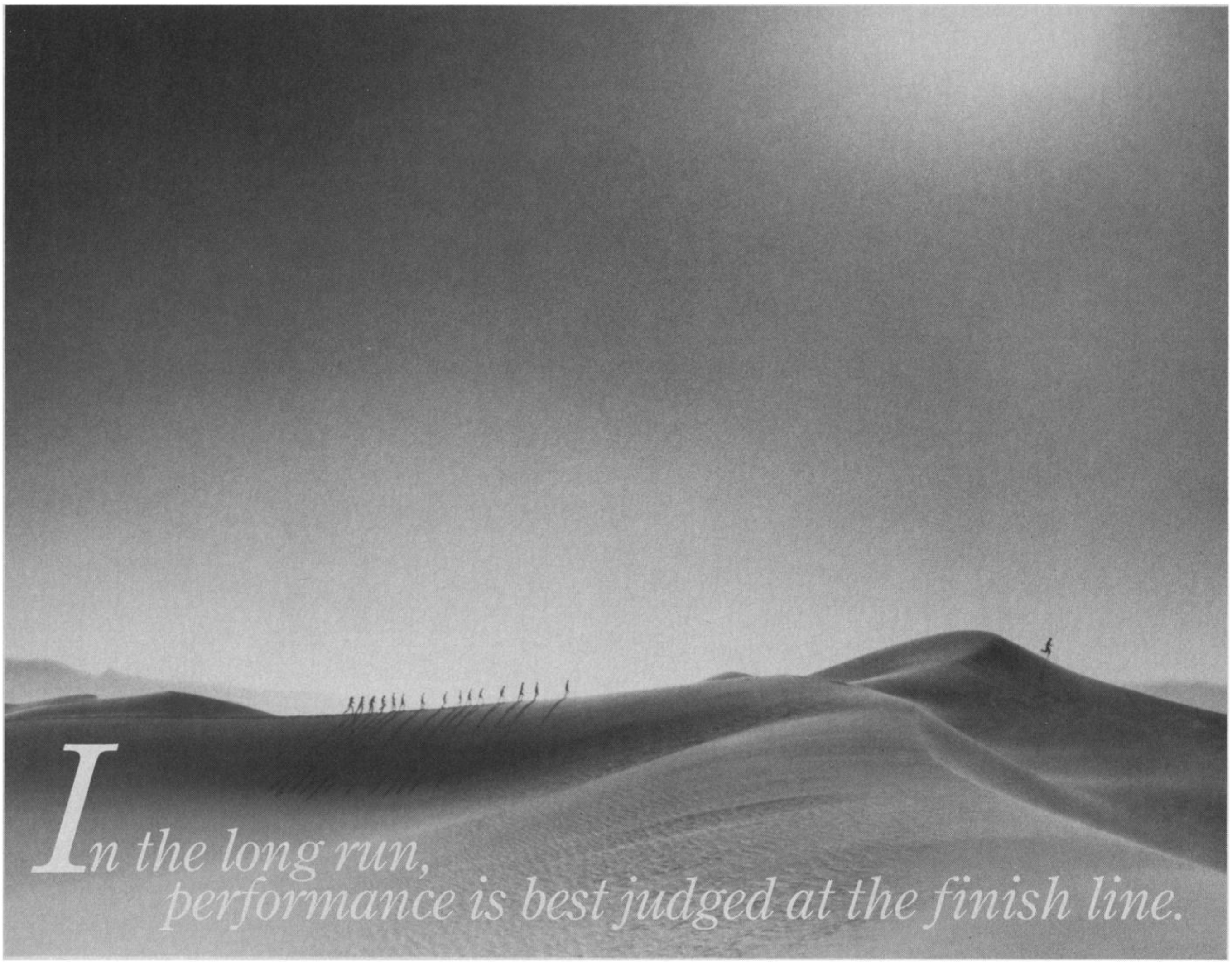
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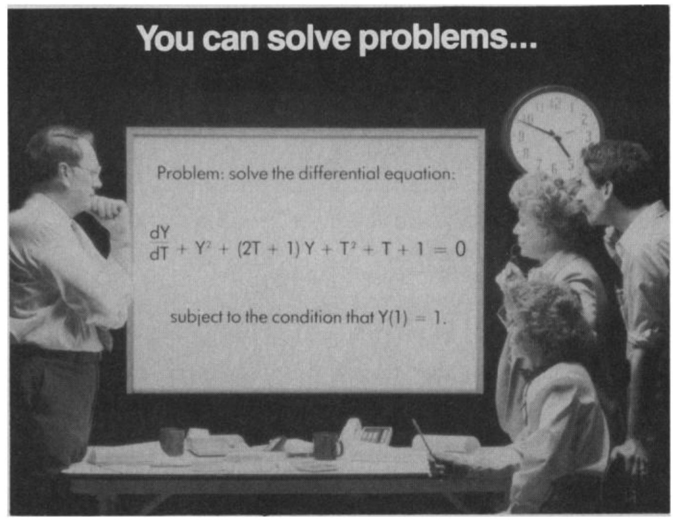
performance is best judged at the finish line.

MACSYMA solves mathematical problems analytically.

Now you can do algebra, calculus, differential equations. Simplify, factor and expand equations. Compute with matrices. And more. Symbolically.



If you work with quantitative models in scientific or engineering disciplines, MACSYMA can increase your modelling power. MACSYMA combines symbolic and numeric computation. And enables you to accurately manipulate symbolic expressions in a fraction of the time required manually.

Wide range of capabilities

MACSYMA offers the widest range of capabilities for symbolic computations in applied mathematics of any commercially available program. For example:

Algebra: MACSYMA can manipulate large expressions, expand, simplify and factor expressions, handle matrices and arrays and solve systems of equations.

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Symbolic-Numeric interface: MACSYMA can generate FORTRAN coding of expressions for numerical analysis or perform numerical analysis in the powerful MACSYMA™ language.

Post-Processing: MACSYMA can plot in 2 or 3 dimensions and interface to standard mathematical text composers.

Symbolically...

(C1) DEPENDS(Y,T)$

(C2) DIFF (Y,T) + Y^2 + (2*T + 1)*Y + T^2 + T + 1;

(D2) $\frac{dY}{dT} + Y^2 + (2T + 1)Y + T^2 + T + 1$

(C3) SOLN:ODE(D2,Y,T);

(D3) $Y = -\frac{\%C\, T\, \%E^T - T - 1}{\%C\, \%E^T - 1}$

(C4) SOLVE(SUBST([Y = 1, T = 1],D3),%C),NUMER;

(D4) [%C = 0.5518192]

(C5) SPECIFIC SOLN:SUBST(D4,SOLN);

(D5) $Y = -\frac{0.5518192\, T\, \%E^T - T - 1}{0.5518192\, \%E^T - 1}$

and Numerically.

(C6) FORTRAN(D5)$

Y = – (0.5518192*T*EXP(T) – T – 1)

1 /(0.5518192*EXP(T) – 1)

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Symbolics, Inc.
Eleven Cambridge Center
Cambridge, MA 02142

Name

Title

Company

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