11 MARCH 1983 · VOL. 219 · NO. 4589 $2.50

# SCIENCE

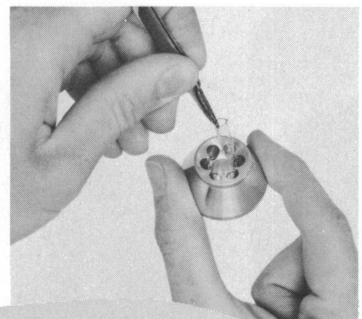
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

# You Separate Small Samples in a Hurry at 95,000 rpm with the Airfuge® Ultracentrifuge

The Airfuge® miniature ultracentrifuge is one of the most useful developments in centrifugation in years. It reaches speeds of 95,000 rpm and generates forces of 178,000 g in less than a minute, so your work gets done fast.

Now there's an optional Digital Speed Readout that displays rotor speed throughout the run. This new accessory is particularly useful for molecular weight determinations, and is a convenience any time.

Five rotors are available for the Airfuge: two fixed angle rotors that hold microliter-sized tubes; the EM-90 Rotor for preparing particles for electron microscopy; the Batch Rotor for pelleting 2 to 7-ml size samples; and the Chylomicron Rotor for clarifying lipemic sera.



So whenever your small samples need high forces, think of the efficient, quiet Airfuge ultracentrifuge. For more information about the Airfuge and its many applications, write for SB-557 to Beckman Instruments, Inc., Spinco Division, 1117 California Avenue, Palo Alto, CA 94304.

Circle No. 335 on Readers' Service Card


**BECKMAN**

ISSN 0036-8075

11 March 1983

Volume 219, No. 4589

# SCIENCE





**SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.** Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with **The Scientific Monthly**®  Domestic individual membership and subscription (51 issues): $48. Domestic institutional subscription (51 issues): $85. Foreign postage extra: Canada $24, other (surface mail) $27, air-surface via Amsterdam $55. First class, airmail, school-year, and student rates on request. Single copies $2.50 ($3 by mail); back issues $3 ($3.50 by mail); Biotechnology issue, $5 ($5.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number.  **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

**COVER**

Simulated vase, assembled from scale molecular model, inspired a two-step synthesis of the compound it represents. The enforced concave interior of the compound makes it a cavitand (a molecular container) capable of hosting guests of moderate molecular dimensions. See page 1177. [Donald J. Cram, Department of Chemistry, University of California, Los Angeles 90024]

## An IBM 3081: subatomic physics at Stanford

# Finding the pieces in one billionth of a second.

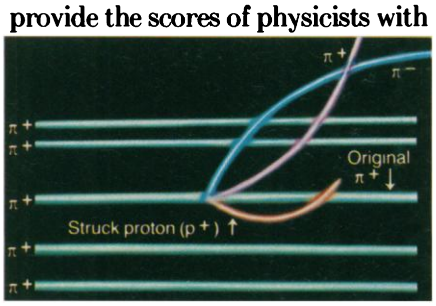
Trying to see how a watch works by slamming two together and examining the pieces is a popular analogy with physicists. It explains how they examine the innermost secrets of subatomic particles.

The watches represent matter and antimatter—electrons and positrons that whirl in opposite directions through a 1.3-mile ring at the Stanford Linear Accelerator Center (SLAC). Approaching the speed of light, they collide and generate bursts of subatomic shards that last for only a tiny sliver of time.

An IBM 3081 processor at SLAC has proved a smashing success in finding meaning in millions of bits

of data from these experiments, which may run for weeks or months.

As Charles Dickens, director of SLAC computing services, says, "Our 3081 moves data in and out of its central processor fast enough to provide the scores of physicists with immediate access to experimental results."



A significant event at SLAC. Positive pion ($\pi^+$) strikes proton ($p^+$) creating two new pions, one negative and one positive. Four other pions pass through with no contact.

They can think about the problem, and not worry about the computer, with microcode-assisted VM/CMS. With this flexible IBM software and the 3081's reliability, physicists can, with confidence, steal a look for a significant event during the experiment.

Dickens explains, "Before, people might say, 'If I'd only known what was happening, I'd have done things differently.' Now they see the results as they happen."

The 3081 supports 450 terminals for interactive computing under VM/CMS. It performs well in online environments because a new dyadic design allows its two separate processors to work concurrently on a wide range of applications. Its high reliability is due, in part, to an advanced thermal conduction module (TCM).

IBM offers engineering and scientific users extensive support: consultants, education and access to professionals. Tap into our many years of experience.

*For an informative brochure, write Dr. Jack W. Hugus, IBM Engineering and Scientific Marketing, 1133 Westchester Avenue, White Plains, NY 10604.*

IBM®

# For scientific computing high price for

## The FPS-164 Attached Processor— A Unique Solution for Cost-Effective Scientific Computing.


Now, VAX™, IBM, Sperry and Apollo users can get a powerful tool specifically designed for solving computationally-intensive problems.

It has the speed, accuracy and memory capacity to solve large-scale scientific and engineering problems—the kind that overload the capability of your general purpose computer and make you wish you could afford a supercomputer. Yet you can buy it for a fraction of the cost of a supercomputer.

Floating Point Systems presents the FPS-164 Attached Processor.

### The Attached Processor Concept

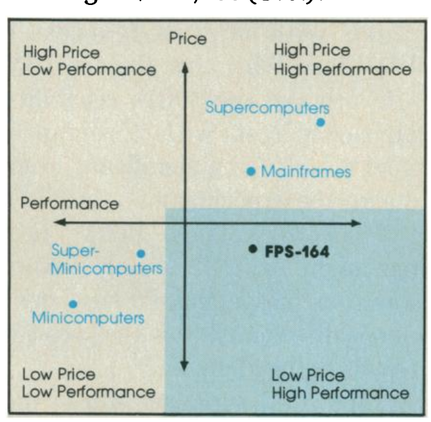
When attached to a VAX, IBM, Sperry or Apollo system, the FPS-164 offloads and processes computationally-intensive tasks, leaving the host computer free for other work. The FPS-164 will expand your computer's capability, relieve its overload and make it possible to solve problems that your system previously could not.

There's no need to replace your system.

### Price/Performance

Compare the price/performance of the FPS-164 to other options for scientific computing.

It offers up to 12-million floating-point computations per second (MEGAFLOPS), gives you 15 decimal digits of precision, and up to 7.25 Megawords (58 Megabytes) of memory for prices starting at $300,000 (U.S.).




### Solutions Using Sparse Matrices

$$\begin{bmatrix} c_1 & d_1 & 0 & e_1 & & & & & & \\ b_2 & c_2 & d_2 & 0 & e_2 & & & & 0 & \\ 0 & b_3 & \cdot & \cdot & \cdot & \cdot & & & & \\ a_4 & 0 & \cdot & \cdot & \cdot & \cdot & \cdot & & & \\ & a_5 & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & & \\ & & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & e_{n-3} & \\ & & & \cdot & \cdot & \cdot & \cdot & \cdot & 0 & \\ & 0 & & & \cdot & \cdot & \cdot & \cdot & d_{n-1} & \\ & & & & & a_n & 0 & b_n & c_n & \end{bmatrix}$$

Many scientific and engineering applications use sparse matrix methods in their problem solving. The FPS-164 is especially suited for these operations which can account for up to 95% of the CPU time.

# you don't have to pay a performance.

For example, a FORTRAN program performing a common sparse matrix operation ran 6 times faster on the FPS-164 than on a popular scientific super-minicomputer. When the program was modified to take advantage of the FPS-164 architecture, the sparse matrix operation ran over 14 times faster than on the super-minicomputer.

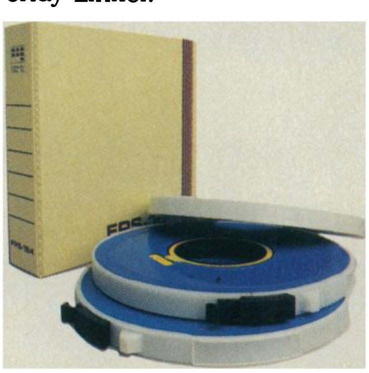
The FPS-164 is presently being used in applications such as computational chemistry and physics, structural analysis, finite element analysis, oil reservoir modeling, and electronic circuit design.

## Ease of Use

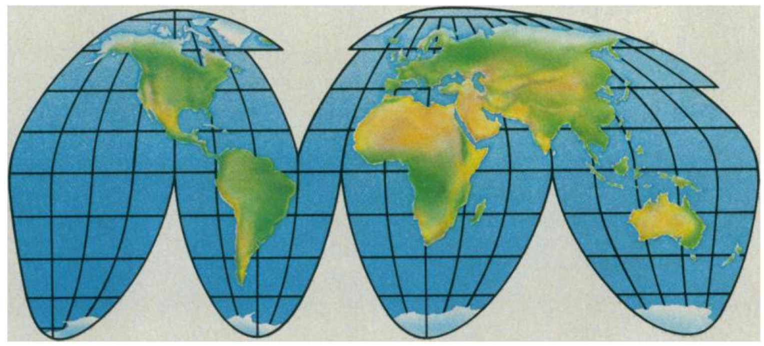
There's no need to reconstruct your program. With the Single Job Executive, you run complete jobs on the FPS-164 Attached Processor as easily as using your own familiar computer. You continue to use your existing system for transferring files to the attached processor and for retrieving the results.

## Ease of Programming

For software development, Floating Point Systems offers development tools for getting maximum use from the FPS-164, including the FORTRAN 77 Optimizing Compiler, and an Overlay Linker.



A Math Library with over 410 FORTRAN callable subroutines is also available.



## Superior Reliability and Worldwide Support

Floating Point Systems has established an impressive record for reliability of products and customer support. Over 4,000 attached processors have been delivered and are being supported with service facilities at key locations throughout the world, remote diagnostic, comprehensive documentation and software support, installation, training and more.

## Call Us

If you need improved price/performance from a scientific computer, call Floating Point Systems, toll free at (800) 547-1445.

Circle No. 309 on Readers' Service Card

**The world leader in array processors.**

FLOATING POINT SYSTEMS, INC.

P.O. Box 23489
Portland, OR 97223
(503) 641-3151
TLX: 360470 FLOATPOIN BEAV

**FPS Sales and Service Worldwide.**
**U.S.:** Albuquerque (NM), Atlanta (GA), Dedham (MA), Denver (CO), Hartford (CT), Houston (TX), Laguna Hills (CA), Los Angeles (CA), New Orleans (LA), New York (NY), Orlando (FL), Palo Alto (CA), Philadelphia (PA), Rockville (MD), Schaumburg (IL), Seattle (WA).
**INTERNATIONAL:** Canada — Calgary, Montreal, Ottawa; England, Bracknell, Berkshire; France, Rungis; Japan, Tokyo; Netherlands, Gouda; West Germany, Haar.

**DISTRIBUTORS:** Australia and New Zealand, Milsons Point, N.S.W. (Techway PTY. (LTD.); Austria, Vienna (Elektronische Bauelemente Und Geräte); Finland, Helsinki (OY Emmett AB); India, Bombay (Hinditron Computers PVT, LTD.); Israel, Tel Aviv (Eastronics, LTD.); Korea, Seoul (Korea Computer Center, Inc.); Singapore (Scientek Corporation); Southern Africa, Johannesburg (Anker Data Systems); Sweden and Norway, Vaxholm (Tre Konsulter AB); Taiwan and Hong Kong, Taipei (Scientek Corporation).



## Send for our brochure.

Floating Point Systems' colorful 20-page brochure provides more information on the unique price/performance advantages of the attached processors.

Name

Title Company

Address City

State/Province Zip/Postal Code

Country if outside U.S.A. Telephone

My application/use is:

SC

# A new generation of microscopes with advanced optical engineering and ergonometric design:

## Olympus BH-2 System Series.


This could well be a most significant contribution to the science of microscopy and photomicrography.

The Olympus BH-2.

Fulfillment of operational, illumination and brightness control goals.

Unsurpassed totally new LB optics provide vastly superior image quality.

New operational superiority improves viewing comfort and offers a natural eyepoint position.

Low position focusing and stage movement knobs provide natural hand positioning.

Improved Koehler illumination is developed for ultra-low magnifications (1x to 4x); and standard magnifications (2x to 100x).

Add precision L.E.D. brightness controls and a host of accessories (phase contrast, Nomarski interference contrast, Hoffman modulation contrast, reflected and transmitted light fluorescence, polarized light and more) and you have today's state-of-the-art development inviting your examination.

Contact the Olympus Authorized Dealer listed in your Yellow Pages, or Precision Instrument Division, Olympus Corporation of America, 4 Nevada Drive, New Hyde Park, NY 11042.

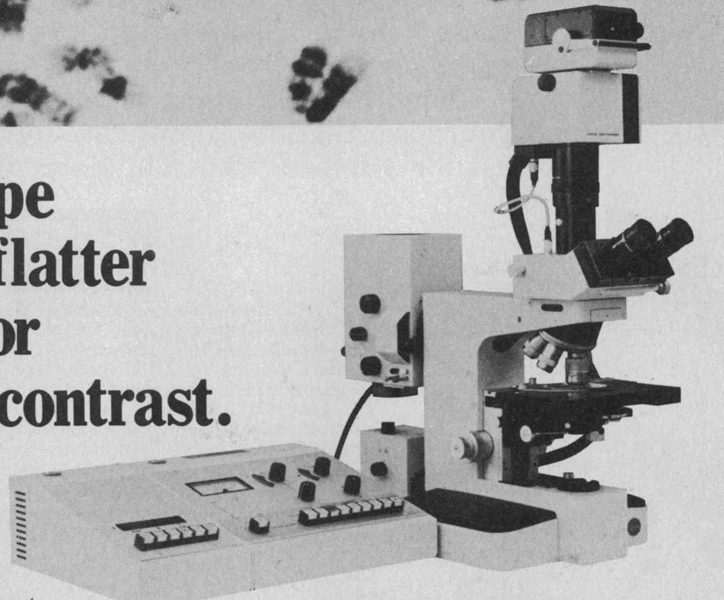
*In Canada, W. Carsen Co., Ltd., Ontario*

**OLYMPUS®**

The Science Company

Circle No. 11 on Readers' Service Card


# New Leitz microscope objective produces flatter images with superior definition & higher contrast.



Leitz Orthoplan® widefield microscope with Vario-Orthomat photomicrographic system – an ideal instrument for the PL APO 63/1.40 objective.

Microscopists who require medium magnification with the highest possible resolving power and apochromatic correction will love the new Leitz® plano apochromatic 63/1.40 objective. It produces a flatter image with better definition and higher contrast than any currently available objective in this magnification range. It is ideal for observation and photomicrography of detail at the limits of the light microscope's resolving power, such as chromosome banding patterns, shown above.

Newly developed anti-reflective lens coatings and cements with high transmission in the violet and near ultraviolet regions make it especially suitable for fluorescence techniques using fluorochromes that excite under UV light, such as the Hoechst fluorochrome. Conventional objectives are opaque in UV light and consequently useless for cytogenetics fluorescence applications.

The PL APO 63/1.40 objective is compatible with all Leitz microscopes, including the Orthoplan® with its 28mm wide field of view. It is available in both brightfield and phase contrast versions. Call or write E. Leitz, Inc., Rockleigh, NJ 07647. (201) 767-1100.

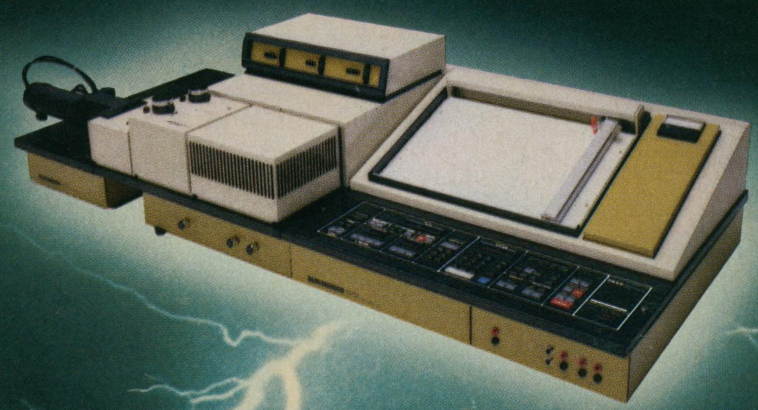
**Leitz Means Precision. World Wide.**

Leitz

R-2754

Circle No. 257 on Readers' Service Card

# SUPERCHARGED.



**Microprocessor controlled electronics brings you even greater flexibility and ease of operation with our new dual-wavelength, double-beam DW-2®C UV-VIS Spectrophotometer.**

New microprocessor controlled electronics gives you automatic baseline correction, digital readout of absorbance, transmittance or concentration, addition and subtraction of spectra or reaction data, memory plot on the built-in recorder, 14 spectral storage locations, first or higher order derivatives, a convenient RS-232 serial interface, plus logarithm, smoothing and averaging routines.

This state-of-the-art system gives you the ultimate combination of flexibility and ease of operation. Supercharge your research with the double-beam, dual-wavelength capabilities of the new DW-2®C UV-VIS Spectrophotometer.

Our staff will be happy to answer any of your questions or send you free literature about the DW-2®C UV-VIS Spectrophotometer and the wide range of accessories designed around it. Write SLM Instruments, Inc./American Instrument Company, 810 W. Anthony Drive, Urbana, IL 61801 U.S.A., or call (800) 637-7689 toll-free. TELEX 20-6079.

**SLM·AMINCO**™

*Performance is the difference.*

Circle No. 320 on Readers' Service Card

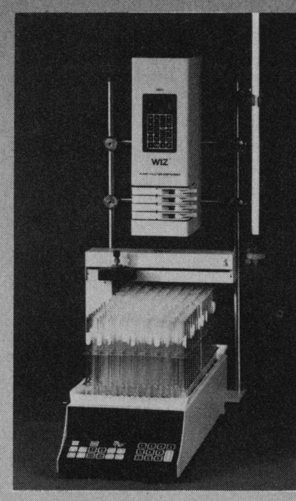
# WIZ™ is ISCO's new smartpump. It's a dispenser and diluter, too.


ISCO's WIZ is more than an ordinary peristaltic pump. Spend two minutes calibrating it when you first set it up—from then on, just key in any flow rate you want, directly in ml/hr. The output will be within 1% of your selected value.

As a dispenser, you can key in any volume—that's what you'll get every time you press the button. Or use it for a diluter: push a button to take up any desired volume of sample; push it again to dispense the sample followed by any volume of diluent.

WIZ has four channels, an LED display, and tubing cassettes that require no pressure adjustment and can be slipped in and out even while running. It also has design and construction quality features not found in most other pumps: microprocessor control, ball bearings, an all-metal frame and cabinet, and gear driven counter-rotation on the rollers. That means it's easy on pump tubing, reliable, and long lived.

**It's a smartpump.** WIZ is suitable for eluting chromatographic columns, circulating buffers and coolants in electrophoresis apparatus, and for many other laboratory applications. WIZ gives you quick system setup—you know immediately what the flow rate will be without measuring effluent or performing any calculations. You can key in any flow rate from 0.02 to 500 ml/hr/channel, combining channels to get a total of up to 2000 ml/hr. When you use WIZ with any ISCO fraction collector, you can select the fraction volume directly on the fraction collector controller. If you want 12 ml fractions, you set "12" on the fraction collector and that's what goes into each tube, regardless of selected flow rate. You can't do this with any other pump.



Wiz mounts on an ISCO FOXY fraction collector to give you the most sophisticated low pressure LC system you can put together.

**It's a dispenser.** Use WIZ for pipetting stock solutions, adding nutrient to culture tubes, filling ELISA plates, and for other batch assay applications. An optional dispenser handle makes the job easy.

**It's a diluter.** WIZ is suitable for preparing samples and standards for many analytical instruments, making serial dilutions for RIA and enzyme assays, dispensing a sample with a nutrient solution for culture assays, etc. A separating air bubble can be added after each cycle if desired.

WIZ can also be an important part of your custom automation design: use it with an ISCO ISIS AutoSampler to automate reagent addition, dilutions, and other lab processes. Send now for literature on this unique new pump, or phone toll-free: **[800] 228-4250.** ISCO, P.O. Box 5347, Lincoln, Nebraska 68505.

ISCO

Circle No. 296 on Readers' Service Card


# HAVE WE GOT POTENTIAL!

**Indeed we do:** fifty-plus specialized electrodes with the potential to give you fast response and precise measurements — right from the first. Made by Fisher with rugged, quality construction — so you can make use of their potential to the fullest.

**Potentially perfect.** Stringent quality control makes sure that Fisher Electrodes will meet your every expectation. We check 'em at each step of the manufacturing process, as carefully as you monitor your own lab procedures. Any imperfections or structural weakness in raw materials — like tubing or cable — mean immediate rejection. We take all the responsibility for the most critical parameters ourselves: filling solutions are mixed and tested in our own labs, and our pH-sensing glass membranes — made to an exclusive Fisher formula — must meet the strictest specs.

**Potentials in action.** After assembly, each and every Fisher Electrode is 100% tested in use. So you can be sure of solid, stable performance — and better-than-98% conformity to the theoretical response predicted by the Nernst equation. From the very first measurement you make.

**The longevity potential.** Our tough testing means we can make you this guarantee of performance: any Fisher Electrode that's properly matched to the sample, and regularly cleaned and maintained, will not fail in normal use due to materials or workmanship for one full year. Or we'll replace it at once.

**Get full potential from every Fisher Electrode.** To get the most out of Fisher Electrodes, just treat 'em right. We'll help you get more measurement mileage — with a copy of the Fisher Electrode Handbook. It has all you need to know to keep your Fisher Electrodes working longer for you.

It tells how to select the right electrodes to match your samples. How to clean, maintain, unblock and even rejuvenate electrodes for renewed performance and extended life. And it includes a concise review of pH basics, plus complete specs for the Fisher Electrode line. It's yours free from the Electrode Experts at Fisher. Just ask your Fisher Representative; call (412) 562-8543; or circle our number on the reply card.

**Fisher Scientific**

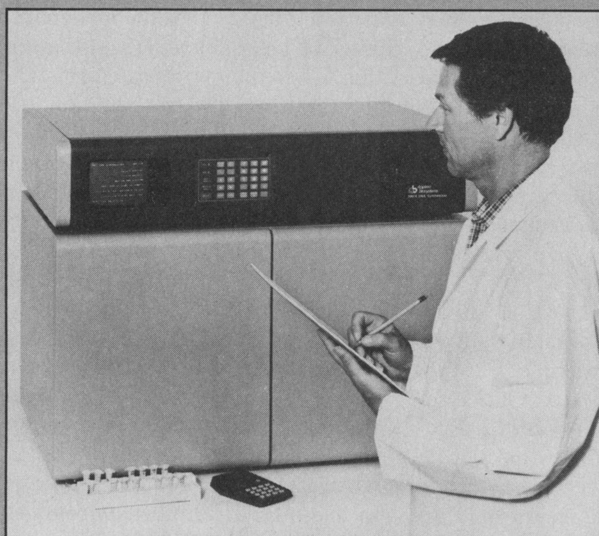
An ALLIED Company

Circle No. 327 on Readers' Service Card

# BIOSYSTEMS UPDATE

## A New DNA Synthesizer with Guaranteed Performance

Applied Biosystems is pleased to introduce its new Model 380A DNA Synthesizer. It is the first and only instrument of its kind which addresses all the critical elements of auto-

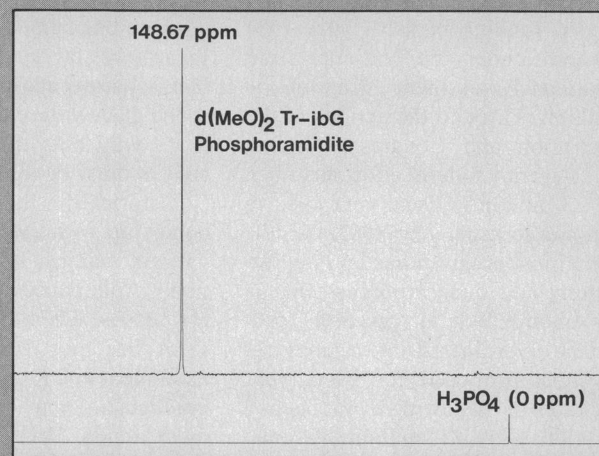


The Model 380A features automatic phosphate deprotection and removal of the DNA from the solid support. With optional memory, the unit can also be reprogrammed by the user to accommodate other chemistries.

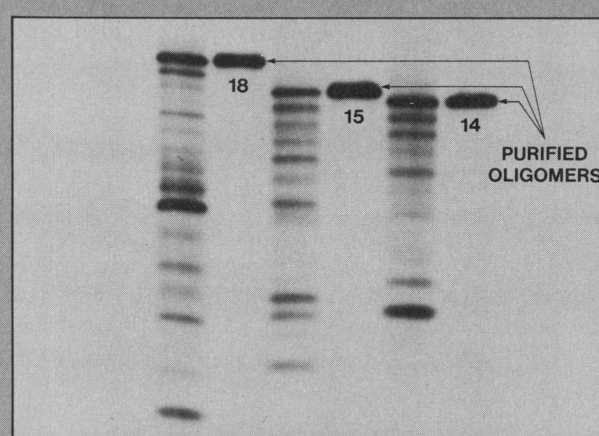
mated oligonucleotide synthesis: stable, efficient chemistry...reliable mechanical design...simple, user-friendly programming that requires no computer knowledge...and a proven protocol which assures fast, successful syntheses at a low cost per cycle.

The synthesizer is designed for reliability, with the same microvalves used in our Model 470A Gas-Phase Protein Sequencer. All reagent deliveries are gas-pressure driven. There are no mechanical pumps or syringes. Reagents contact only fluorocarbon polymers and glass and there is no need to clean or backflush the system after use.

The licensed phosphoramidite chemistry of Applied Biosystems is unique: the reagents have virtually indefinite shelf life and maintain their high efficiency after weeks of operation in the instrument. Base addition cycle times are under 20 minutes and coupling efficiency is typically 95%. Synthesis at one micromole uses only 15mg. of nucleoside phosphoramidite per cycle.




No DNA synthesizer is better than its reagents. Our phosphoramidite nucleosides are synthesized to exacting purity standards: each lot is $^{31}$P NMR quality-assured and a copy of the spectrum is included in every shipment.




Analytical autoradiogram of the crude isolates of three automated syntheses with their corresponding purified oligonucleotides.

For more information circle #235.

Applied Biosystems

APPLIED BIOSYSTEMS, INC., 850 Lincoln Centre Drive, Foster City, CA 94404 • (415) 570-6667

IN EUROPE: APPLIED BIOSYSTEMS GMBH, 104 Bergstrasse, D6102 Pfungstadt, West Germany • 06157-6036

11 March 1983, Volume 219, Number 4589

# SCIENCE



# Progress Report on Engineering Education

The need for action to meet the national crisis in engineering education remains acute. That is a chief conclusion of a follow-up report on the National Engineering Action Conference (NEAC) held last April.* The report was based in part on a survey of 32 engineering deans conducted by the Project on the Engineering College Faculty Shortage.† The deans agreed, usually by large margins, that:

- The engineering faculty shortage remains critical.
- Engineering schools are still losing faculty to industry, though at somewhat lower rates.
- Engineering faculty salaries are being raised.
- Graduate enrollment is noticeably increasing.
- Equipment and facility problems are beginning to be addressed.

Much remains to be done. As noted in a recent report,‡ the present dangers to the quality of engineering education have been masked by the abilities of the students accepted by the engineering schools. Admissions officers now have the dubious luxury of being even more selective. Thousands are being turned away as the engineering schools struggle to maintain educational quality by balancing resources against enrollments.

While the nation strives to upgrade industrial productivity, expand employment, and bolster national security, the engineering schools are being forced to forgo invaluable opportunities to produce young engineers with educations commensurate with their talents. Between 1975–1976 and 1980–1981, the ratio of students to faculty at most institutions shot up 30 to 50 percent. In overcrowded lecture halls, students are seen but not heard. In crammed laboratories, where experimental work deteriorates into mere demonstration, students may look but not touch. And with grossly inadequate capital budgets at the schools, students can read about state-of-the-art equipment but almost never use it.

There are, however, tangible signs of progress. At the state level, the Project on the Engineering College Faculty Shortage has cataloged more than 50 initiatives proposed to state governments by local academics, industry, and the professional societies. Almost half of these have brought funding by state governments, and many entail joint funding with industry. A similar catalog shows that industry has committed at least $75 million to meeting the problem in the form of faculty grants, fellowships, equipment donations, and university-industry cooperative research agreements. To this can be added IBM's new $50 million program to support education in manufacturing systems engineering. At the federal level, write-off provisions in the Economic Recovery Tax Act of 1981 have stimulated equipment donations to colleges and universities. And the National Science Foundation and the Department of Defense have expanded their programs-in-aid to engineering education.

In short, within this diverse, pluralistic nation, the movement to protect the quality of engineering education is gaining momentum. But the needs still far outweigh the resources being applied. In the few months since NEAC, perhaps the most hopeful sign is the growing realization that all the sectors involved can and must help resolve the situation. Many models exist, including the "action examples" produced by NEAC and those collected by the Project on the Engineering College Faculty Shortage. In reaching our pressing national goals, success will depend to a great degree on how widely and well these models are translated into further action.
—EDWARD E. DAVID, JR., *President, Exxon Research and Engineering Company, Florham Park, New Jersey 07932*

---

*E. E. David, Jr., *Science*, 30 April 1982, p. 465. †Sponsored by the American Association of Engineering Societies and the American Society for Engineering Education. ‡Prepared by the National Association of State Universities and Land-Grant Colleges.

# THE NEW DAS SERIES 500 FOR THE IBM PC:


# THE DATA ACQUISITION & CONTROL SYSTEM YOU SHOULD CONSIDER OVER A MINI. EVEN IF MONEY IS NO OBJECT.

Let's say you have enough money to buy nearly any data acquisition and control system you might want. What will you choose?

If sheer power is your main requirement, you might choose an expensive minicomputer system. But, then again, you might just as well choose the new DAS Series 500.

Simply plug the Series 500 into any off-the-shelf IBM Personal Computer and you'll have up to 336 channels of analog input, 60 channels of analog output and 192 channels of digital I/O (even AC/DC device control). And with measurement speeds as high as 25,000 analog data points per second, and true 12 or 14 bit precision, you'll have enough power and accuracy for the most demanding applications.

If you need flexibility, you'll want to compare other, more costly systems to the fully modular Series 500. It comes supported by an extensive library of integrated plug-in modules that let you custom tailor almost any combination of inputs and outputs, digital or analog. And do so almost instantly.

So the Series 500 is ideal for hundreds of applications in product test, process control and energy management; in psychology, biology, analytical chemistry and neuroscience.

If ease of use is high on your list, consider this: Only the Series 500 comes equipped with the advanced, integrated Soft500 software package. With it, you can set up, collect, store, control, display and analyze, all with a few simple BASIC commands.

In fact, Soft500 makes programming so easy, you can be up and running with your Series 500 the same day you get it. Even if you're not a computer expert.

Now compare advanced features. Like exclusive foreground/background software architecture that lets you analyze data while you collect it. Like the real-time clock/calendar and precision interval timer. Or the tremendous range of signal conditioning options, including software selected gain and offset, amplification from millivolt levels, and provision for direct connection of thermocouples, strain gauges and RTDs.

These are features you might not get elsewhere, no matter how much money you spend. But then, why spend all that money?

Because for less than $6000 you get both the advanced capabilities of the DAS Series 500, plus an IBM PC* (which incidentally, you can still use to do all the other things a PC does so well).

For complete information on the DAS Series 500 data acquisition and control system, write to us at Data Acquisition Systems, Inc., 349 Congress Street, Boston, Massachusetts 02210. Or call us at 617 423-7691.

das

Circle No. 344 on Readers' Service Card

*IBM PC purchased separately. Also available for the Apple II.
IBM PC & Apple II are registered trademarks.