SCIENCE

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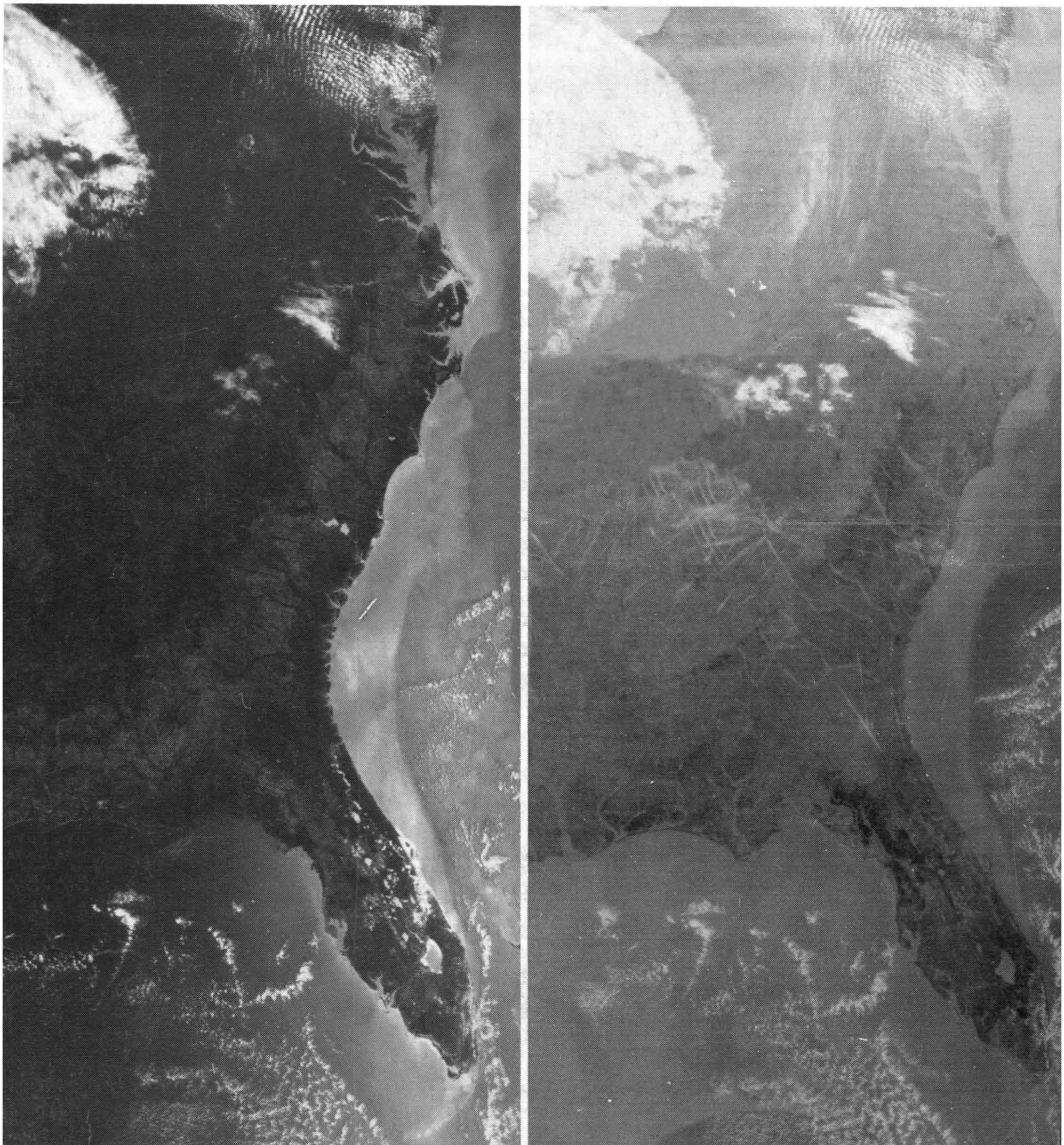
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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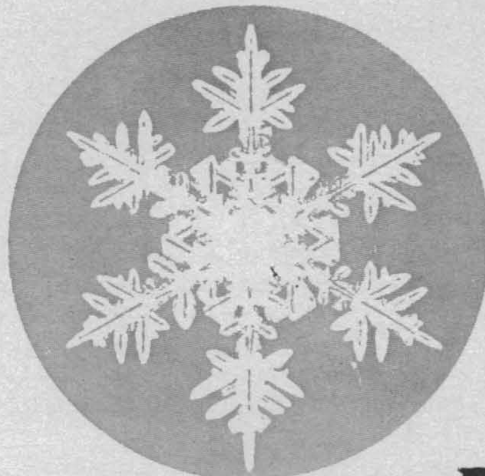

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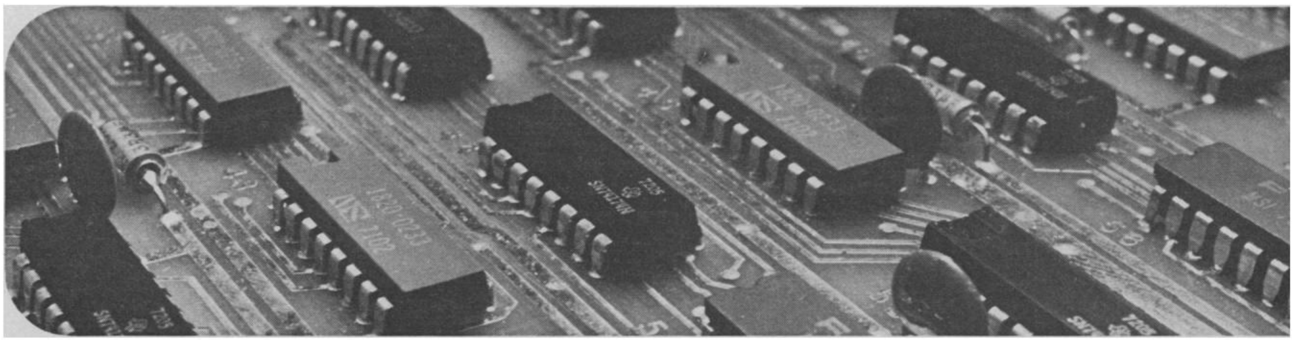
COVER

Simultaneous visible (left) and thermal infrared (right) images of the southeastern United States and adjacent Atlantic Ocean reveal a discontinuity in surface roughness across the Gulf Stream front. See page 482. [National Environmental Satellite Service, National Oceanic and Atmospheric Administration]

How to live more comfortably in an increasingly digital world.

In the continuing technological evolution, television sets, automobiles and even kitchen appliances are beginning to use digital electronic circuits once limited to computers.

Having come up against these complications in our own manufacturing and service operations, we've developed a family of instruments that complement the traditional oscilloscopes, DVMs and counters for digital circuit test and analysis. As you read on, you'll learn how these instruments provide easier, faster and more accurate solutions to digital problems.



In the digital world, it's the mere presence or absence of electrical pulses — or their on-off pattern in time — which conveys the information needed for computation, control or communication. In analog circuits, the data conveyed comes from the amplitude or rate of change of electrical signals. Because of this fundamental difference, the many benefits of digital electronics are accompanied by a new set of problems for designers and troubleshooters.

If you've ever had to troubleshoot a digital circuit with traditional analog instruments, the experience probably convinced you there should be a better way.

Take voltage measurement. In an analog circuit, it's important that you know the absolute voltage of a test point, whether it's between 5.015 and 5.018 V., for example. But in a digital circuit, the important thing is to know the logic state of a node, whether it's above the threshold voltage and therefore a logic high, or below the threshold voltage and therefore a logic low.

Time presents another problem. Absolute time measurements are unnecessary in digital systems. Things don't happen after a certain amount of time has elapsed but rather after a certain number of clock pulses, regardless of their duration. The circuit troubleshooter needs to know, for example, if a data bit occurred 1024 clock pulses after an event — and couldn't care less if it took .509 ms to get there.

Furthermore each IC in a digital circuit has 14 or 16 leads and you may need to know what's going on at all the leads simultaneously, not just at two or three input and output leads as with the components of an analog circuit.

The IC troubleshooters pinpoint the circuit problem.

Used singly or in combinations, these instruments are unique in their ability to detect in-circuit logic failures, analyze the cause of the failure and isolate it to a particular IC node.

When the logic clip is attached to an in-circuit IC, it indicates on a bright LED display the logic states at all 14 or 16 pins simultaneously. The clip automatically locates the test IC's ground and power supply, borrows power from it and thus requires no cable connections of any kind. $125.*

The logic probe indicates the condition of a specific IC node and tells you if it's high, low, bad-level or inactive. It captures single pulses as narrow as 10 ns and stretches them to a bright blink at the probe tip. $95* for TTL/DTL or high level logic. $95* for ECL.

The logic pulser teams up with the probe or clip for stimulus-response testing. Typically, you use the pulser to inject reset, shift and clock signals into a circuit, and then observe the effects at a particular IC with the clip, or at an individual node with the probe. The pulser's output is high enough to overcome "clamped" IC outputs yet its pulse is brief enough to prevent circuit damage. $95.*

The logic comparator is a self-contained functional tester that borrows power and input signals from an in-circuit test IC. It instantly compares the logic states of the test IC and those of a reference IC of the same type. Differences are displayed on one of 16 LEDs. Even brief or intermittent failures are detected. $375.*

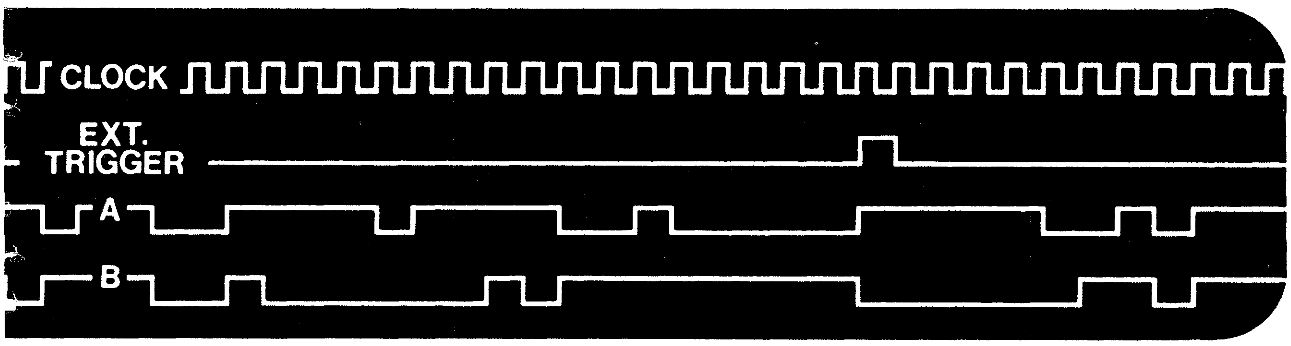
The logic analyzers detect bit-stream problems.

With the instruments described so far, you can determine the logic state of a digital circuit at one particular clock cycle. But if you want to know overall circuit performance and compare it against truth tables or system timing diagrams, you have to learn how the procession of logic states changes with each pulse of the circuit clock.

Two new HP instruments greatly simplify this task. Both extract from long bit patterns the essential information required by the digital troubleshooter: for each successive bit time, is the data (logic state) high or low? The Model 5000A captures 32 successive bits from two parallel channels and displays them as logic highs or lows on LEDs. The Model 1601L does the same job for twelve parallel channels at a time and displays 16 successive bits in each channel, expressed as 1's and 0's on a cathode ray tube.

Both instruments can operate at speeds up to 10 megabits per second, capturing the desired portions of long, non-repetitive bit stream with great flexibility and complete repeatability. You can trigger the display — and therefore the bit-capture — to occur after a single unique event or multiple simultaneous events. You can dial the precise amount of delay you want and thus move the display window forward from the trigger event as many as 10^6 clock pulses (10^5 for the 1601L). With negative delay, you can even look backward in time. You can, for example, trigger the display on a fault condition and see the bit pattern that led to and caused the fault.

The 5000A and the 1601L are compatible with all digital logic families. 5000A, $1900,* 1601L, $2650.*



Automatic circuit tester mass-tests complete digital assemblies.

When you're dealing with large numbers of digital circuit assemblies, manual testing of any sort can be prohibitively expensive or even impossible. This is where the Model 9560B/D Digital Circuit Test System fits in.

This new modular system can simultaneously test all the pins of a complex digital assembly at rates as high as 22,000 truth table patterns per second. Results can be displayed as a simple pass/fail, or extended to specific fault diagnosis using logic probes according to computer-generated instructions. Test programs are written in easy-to-use ATS BASIC; a software package for computer-aided generation of test programs is also available. Prices start at $53,900.*

Our digital capabilities don't stop at the end of this page. The range of HP digital test and analysis includes digital communications testing systems as well as digital pulse generators. For more information on all of the above write to us. Hewlett-Packard, 1507 Page Mill Road, Palo Alto, Calif. 94304.

*US Domestic Prices Only. 00318

Please send me more information on:

( ) IC Troubleshooters
( ) 5000A Logic Analyzer
( ) 1601L Logic Analyzer
( ) 8015A Digital Pulse Generator
( ) 9560B/D Automatic Circuit Tester
( ) 3760A/3761A Digital Communication Test System

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Wade] were interesting to read and took me back to my boyhood, when I enjoyed collecting insects.

In New Hampshire in the summer of 1919 the sugar maples were completely defoliated by the rosy maple moth, *Dryocampa rubicunda*. In 1920 the maples were normal. In the maple forests, my joy, as a collector of beetles, was great because the woods were swarming with *Calosoma frigidum* eating the larvae of the moth. At home in New Jersey, I visited a friend on his farm where potatoes were being dug. The insecticides 50 years ago were not as effective as they are now; that potato field was swarming with *Calosoma calidum*, which had been feeding on larvae of the potato beetle, *Leptinotarsa decemlineata*.

I am not an organic gardener, but in my vegetable patch I cultivate the lazy way with a minimum of plowing and some mulch of leaves and shredded sticks. I have not sprayed or dusted for several years. The corn ear worms and bean beetles are there, but their damage is small.

I suppose my farmer friends are right in saying that it is not economically practical to rely on natural predators for control. I am a chemist and so should probably not speculate, but I wonder what would result if a *Calosoma*, full of eggs, could be kept alive in cold storage to be released when pest larvae were hatching. Clausen (*1*) names many insects, some with unrestricted feeding habits, which might be treated this way. Could not some of these be used to control the gypsy moth?

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501 East Main Street,
Moorestown, New Jersey 08057

References

1. C. P. Clausen, *Entomophagous Insects* (McGraw-Hill, New York, 1940).

University Cooperation with Industry

The spirited discussion by G. D. Cody, W. D. Compton, and R. Roy (Letters, 31 Aug., p. 800) of Roy's article (1 Dec. 1972, p. 955) on university-industry interaction patterns prompts me to mention our experience at Carnegie-Mellon University, where the Processing Research Institute (PRI) was organized with a grant from the RANN (Research Applied to National Needs) program of the National Science Foundation (NSF). PRI benefits from what Cody calls a "troika," in which government funds are used as a "catalyst" to bring industry and the university together in a meaningful way. During the 1972–73 academic year, PRI cooperated with 14 companies in projects having an annual value of $500,000. Approximately 60 percent of the funds were provided by industry.

A key feature of PRI is a 2-year Master of Engineering degree program which provides for a diversified, broad curriculum. PRI attracts problem-oriented graduate students who consider their industry-sponsored project to be a vital part of their education. Aspects of our experience that we think are critical for successful industry-university interaction are (i) an identifiable organization on campus that interacts with industry—at Carnegie-Mellon, the PRI; (ii) a broad base of disciplinary support—in our case, from the departments of chemical engineering, mechanical engineering, and metallurgy and materials science; (iii) sufficient faculty of acknowledged competence who are willing to enthusiastically support this type of activity; and (iv) encouragement and support from the university administration.

As Cody has indicated some doubt concerning the feasibility of an effective industry-university partnership, it is important to mention some of the benefits to the university we have observed in a brief span of time: (i) the development of a problem-oriented graduate program that parallels the traditional discipline-oriented programs; (ii) a broadened outlook on the part of the faculty; (iii) an increased interaction between the three cooperating departments; and (iv) increased support of the graduate program through industry-sponsored projects. From the point of view of industry, the opportunity to provide a positive input to graduate education, especially in the development of new approaches to problem-solving, is gratifying. Representatives of industry who visit our campus seem to benefit from the broad view that our faculty takes of their disciplines, which has led to some unusual solutions to industrial problems.

Finally, one of the objectives of the NSF grant is to experiment with different forms of industry-university interaction. We invite comments and suggestions.

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Carnegie-Mellon University,
Pittsburgh, Pennsylvania 15213

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Environmental Priorities

Billions of dollars are being spent on construction of facilities designed to stem the flow of pollutants into our continental waters. Tens of millions are being spent on research aimed at matching existing technical knowledge with these national needs. Almost nothing is being spent on research devoted to understanding the ecosystems we seek to save. The reason that such monies are not available to the scientific community is as follows. The research aspect of the National Science Foundation has almost no constituency in this area and is hesitant in times of tight appropriations to divert any of its precious funds to this new area—especially since many millions are being devoted to water research by the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Atomic Energy Commission, and other groups, including the National Science Foundation's own new division, RANN (Research Applied to National Needs). Unfortunately, these groups are virtually prevented by legislation from funding anything that has the smell of basic research.

Since we cannot afford the cost of totally stemming the flow of all pollutants, we must go the route of partial control of selected pollutants. Which should we select? By how much should their flow be cut? For example, recent research on phosphorus makes it clear that any cut in the rate at which it enters a eutrophied lake will produce a corresponding cut in the standing crop of algae. This does not mean, however, that by eliminating the flow of phosphorus into the lake we can be sure of solving its algae problem. The reason is that almost all the phosphorus previously added to the lake lies buried in sediment. The degree to which this phosphorus will be recycled is not predictable because we lack sufficient knowledge of the geochemistry and biochemistry of sedimentary phosphorus. There is little point in cutting the flow of new phosphorus much below the rate of return of the old.

By contrast, in many rivers and estuaries, phosphorus and its fellow nutrients go unused by plants. For some reason, plants do not respond to the presence of these basic building blocks in rivers and estuaries as they do in lakes and oceans. Is it the high silt load of rivers, their toxicity, or their rapid rate of flow that prevents response? Until we have the answer, it is not clear whether the steps we are taking to clean up these ecosystems will succeed.

The fate of toxic metals, reactor radioactivities, intestinal bacteria, and organic wastes are even less understood. For every 100 questions that could be asked about the fate of any of these substances, answers exist for only one or two. Even the techniques needed for studies are yet to be developed. Means of measuring the rates of turbulent mixing are yet to be perfected, means of reconstructing chemical histories from the sedimentary record must be devised, and means of monitoring the key dissolved and particular constituents still must be engineered. Computer modeling of these ecosystems is largely without any factual base. Until we know much more about the processes taking place in these ecosystems, the predictive power of these models is at best questionable. A little basic research would bear considerable fruit.

Much could be done if even a modest fraction of the vast research expenditures on these problems were allocated on the basis of the investigator's skill as a scientist rather than on the basis of his willingness to put aside his natural instincts and devote his attention to the immediate needs of some government agency. It is to be hoped that the scientific community will work to correct this problem lest another decade pass and we only then begin to discover how naive our approach has been to the very difficult problem of managing the quality of our waters.—W. S. BROECKER, *Lamont-Doherty Geological Observatory, Columbia University, Palisades, New York 10964*

ITEM: *Airglow*

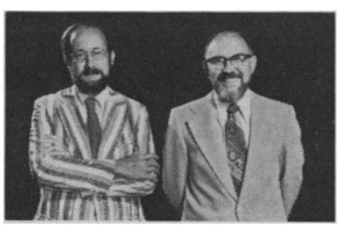
Nature 242:321 reports evidence that direct photography of airglow at *f*/1.2 through KODAK WRATTEN Filter 88A on KODAK High Speed Infrared Film might be an easier way to prepare world-wide synoptic maps of "winds" at the OH layer of the atmosphere than are obtained by vapor releases from rockets or analyzing persistent meteor trails.

ITEM: *Water penetration*

An experimental color film of two layers with peak sensitivities at about 480 and 550 nm, in which magenta and green dyes respectively are formed, is reported to show superior results from aloft in delineating underwater detail and characteristics of the water itself. The film is not yet ready for sale.

As late as the year 1973, such news items still turn up. The photographic emulsion has not yet had all its potential wrung out of it. Nor have all useful changes been rung on it yet.

There is a problem, though: building new properties into modern photomaterials is an undertaking of some dimensions, including the commercial dimensions. Those count because it takes quite a bit of stuff just to wet the equipment. We are simply not clever enough to make do with a beaker and a pancake griddle and get film sufficiently predictable in performance to carry the trademark "Kodak." A scientist who expects to use as much as 1 m^2 of a very special film may resent paying a price for it that covers the 500 m^2 of unsalable goods generated in startup.



Meet two individuals at the interface between such inner realities and outer needs. Scott, with the dark beard, has the task of finding common threads in photographic needs among the biomedical research community (and a few other learned communities). The gray-beard, Hahn, serves astronomers and works inward from their world. Nimbly up and down the scale of technical photographic sophistication, they talk and write the whole day through. To wit:

Kodak, what's your fastest material?

Answer: If you are talking in microseconds, KODAK 2485 High Speed Recording Film (ESTAR-AH Base), stocked only in 150-foot lengths, 35mm or 70mm. If you are talking hours or days, KODAK "Spectroscopic" Plates, Type Ia. Use Ia to demonstrate the presence of light but not to find a faint image amidst other radiation. For that, get IIIa-J and bake for five hours at 65°C under dry N_2 before exposure.

Kodak, is it true that certain of your films are "classified"?

Answer: No.

Let's chat color film. What's your fastest in 35mm?

Answer: KODAK High Speed EKTACHROME Film (Daylight). ASA 160 in normal processing. Can be push-processed to higher speeds by processing labs (to ASA 400 in the case of Kodak Processing Laboratories; other laboratories may go higher). You can also use a KODAK EKTACHROME Film Processing Kit, Process E-4, and regulate effective film speed yourself by time in first developer. Get too far off the recommended time and brace yourself for disappointing image and color quality, if that matters in your application. If you leave the film in overnight, don't blame us for your sad results.

Which color film for high contrast in lecture slides of charts?

Answer: KODAK Photomicrography Color Film. More of it is used that way than in photomicrography, we suspect.

Why do my false-color studies on the KODAK EKTACHROME Infrared Film come out blue?

Answer: Maybe you are not using a KODAK WRATTEN Filter, No. 12 (or equivalent), as recommended.

Why have you quit making WRATTEN Filters?

Answer: We haven't. We've just quit mounting them in glass.

How can I get photographic sensitivity below 250 nm?

Answer: To get down to 200 nm, bathe plates before exposure in Ultraviolet Sensitizing Solution A3177 (sold by lab supply houses that handle EASTMAN Organic Chemicals). KODAK SWR Plates and Film have recorded down to 7.5 nm, but delivery time runs 60 to 110 days, and sensitivity to abrasion runs high. Kodak-Pathé in France makes some films that can give you an order of magnitude more in sensitivity to the deep UV than SWR plates. Check with Ed Hahn.

How can I get above the 900-nm limit of KODAK High Speed Infrared Film?

Answer: Bathe KODAK "Spectroscopic" Plate I-Z for 3 minutes at 5°C in 0.5% aqueous ammonia, then for 2 to 3 minutes in methanol or ethanol. Dry as quickly as possible in stream of cool, dust-free air. Expose and process without delay. Radiation out to 1.28 μm has been recorded that way.

Is that what's used in those infrared cameras to photograph differences in water temperature?

Answer: No. Those are scanners with photoconductive cells cooled by liquid N_2. A resulting CRT display is then recorded photographically on film recommended for the equipment. For subjects below 250°C you don't record temperature differences directly on silver halide.

Do I order these various films from Kodak?

Answer: No, from dealers in professional and industrial photographic goods. The Yellow Pages might guide you to one such. Many are accustomed to serving scientific customers. Just ask.

Keep this page handy for a while but not for too long. The answers are not to be construed as eternal truths. Mail address for this sort of thing: **Kodak, Scientific Photography Markets, Rochester, N.Y. 14650.**

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