SCIENCE

14 October 1966

Vol. 154, No. 3746

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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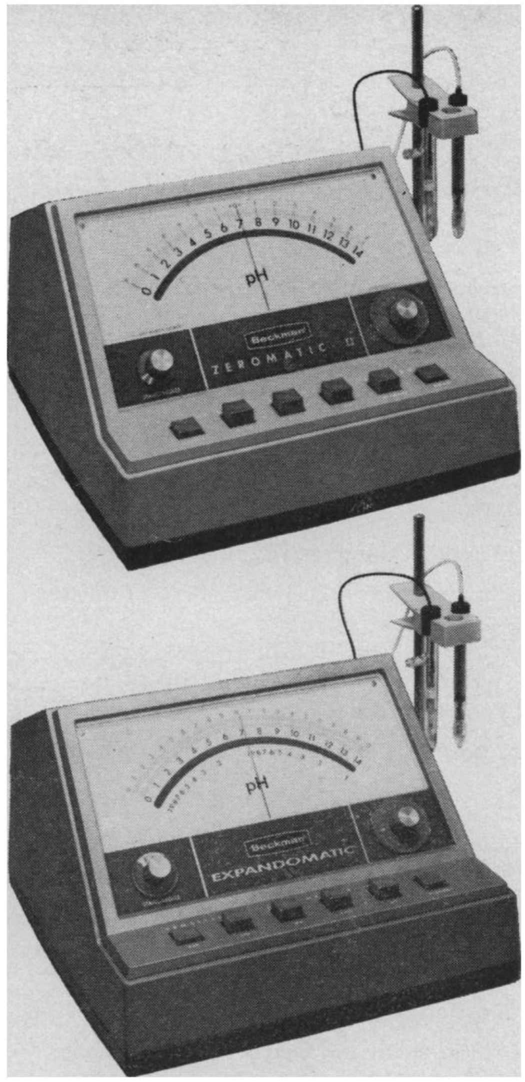

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14 October 1966
Vol. 154, No. 3746

SCIENCE

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COVER

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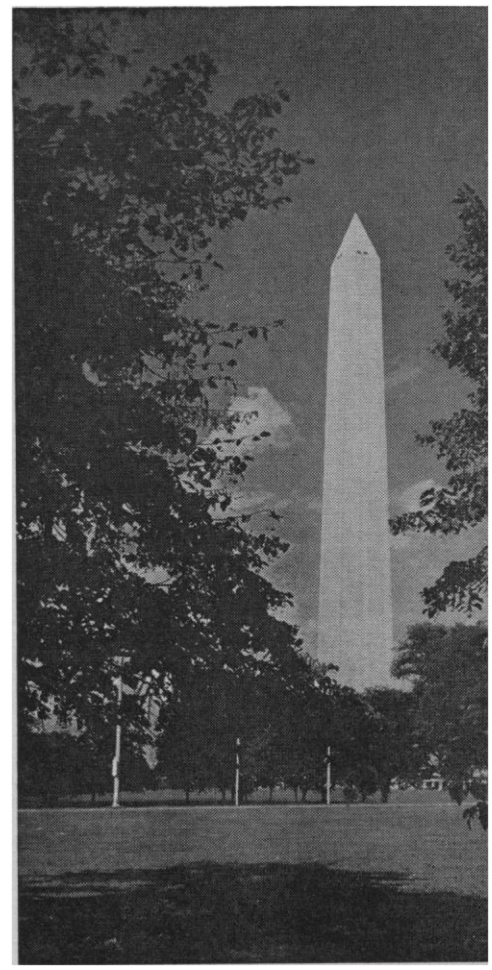

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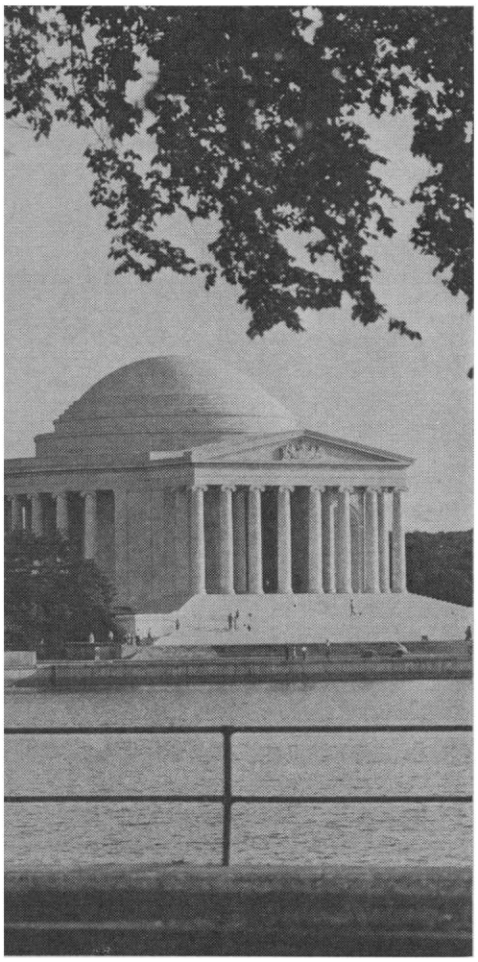

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minimum flush-out Gerard estimated for rapid mixing. If temporary multiple sluices were provided within both dams at appropriate depths, the Sound could be purged through them rather than by spillover. Because of salinity-density stratification, the water flowing through the submerged sluices would be considerably more saline than surface overflow. For sluice flow to match flow into the reservoir, the water level in the fresher Sound must be sufficiently above that in the sea to more than offset the pressure head of the denser sea water overlying the sluices. Furthermore, the sluices must have sufficient capacity for the effective pressure difference to handle reservoir influx. These requirements, considering the lack of tide in the reservoir, seem practical without land encroachment.

Fresh water influx can pump out saltier water than that which would overflow the dams in the plan suggested by Gerard.

HAROLD LAMPORT
Department of Physiology, Mt. Sinai School of Medicine, New York

One possible benefit that Gerard does not mention is the creation of a freshwater harbor by removal of material needed to build the dam. A dam 20 m high, 50 m wide at the top, 90 m wide at the bottom, and 12.8 km long would contain 18×10^6 m^3 of material. This is sufficient to create a hole, which might be used as a harbor, 18 m deep and 1 km square. Such a harbor near the mouth of the Connecticut River could provide sufficient capacity to relieve some of the congestion in New York Harbor.

W. I. NEEF
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Chemotaxis: Divided and Defined

At one time I sided with Disraeli's "I hate definitions." Now it seems as though science proceeds by application of the razor and hone to definitions and I have switched to Emerson: "He shall be as a god to me, who can rightly divide and define." Chemotaxis, as defined by Fraenkel and Gunn (*1*), is a "directed orientation reaction," and implies something about the mechanism of the response. It is not yet clear whether the responses shown by *Escherichia coli* are directed or random in orientation, but Adler ("Chemotaxis in bacteria," 12 August, p. 708) proposes that the mechanism used by *E. coli* is the "avoiding reaction," which Fraenkel and Gunn (*2*) favor as a random *kinesis*. Since Adler's data are not concerned with responses per se, but with the end result of the responses, I suggest that these and other similar results be described as aggregation, or better yet, chemical attraction, a phrase which describes the end result with no commitment to mechanism. A general definition of chemical attraction which may be useful to others in this field is: responses that serve to bring and keep organisms within the vicinity of an attractant (*3*).

Such quibbling over words does not detract from the elegant nature of Adler's experiments. But I feel there is something to be gained by adhering to Fraenkel and Gunn's definitions of chemotaxis and related terms, or improving these definitions.

AUSTIN J. MACINNIS
Department of Zoology, University of California, Los Angeles 90024

References

1. G. S. Fraenkel and D. L. Gunn, *The Orientation of Animals* (Dover, New York, 1961), pp. 10, 53.
2. ———, *ibid.*, p. 57.
3. A. J. MacInnis, *J. Parasitol.* **51**, 733 (1965).

Of Porpoises and Bedbugs

This is a time for rejoicing. Our military researchers (who will spend $7 billion during the next year) have discovered that the porpoise can be used to find enemy submarines by differentiating metals (New York *Times*, 23 April), and the bedbug, by its "yowl" when sensing human flesh, may help to hunt the Vietcong (New York *Times*, 6 June).

An Office of Military Zoology is clearly needed to cultivate this new frontier of science. What valuable spillover for civilian technology may come from these efforts! Perhaps the new Office of Military Zoology could give us the boon of an anti-bedbug (ABB), a zoological equivalent of the anti-ballistic missile (ABM).

SEYMOUR MELMAN
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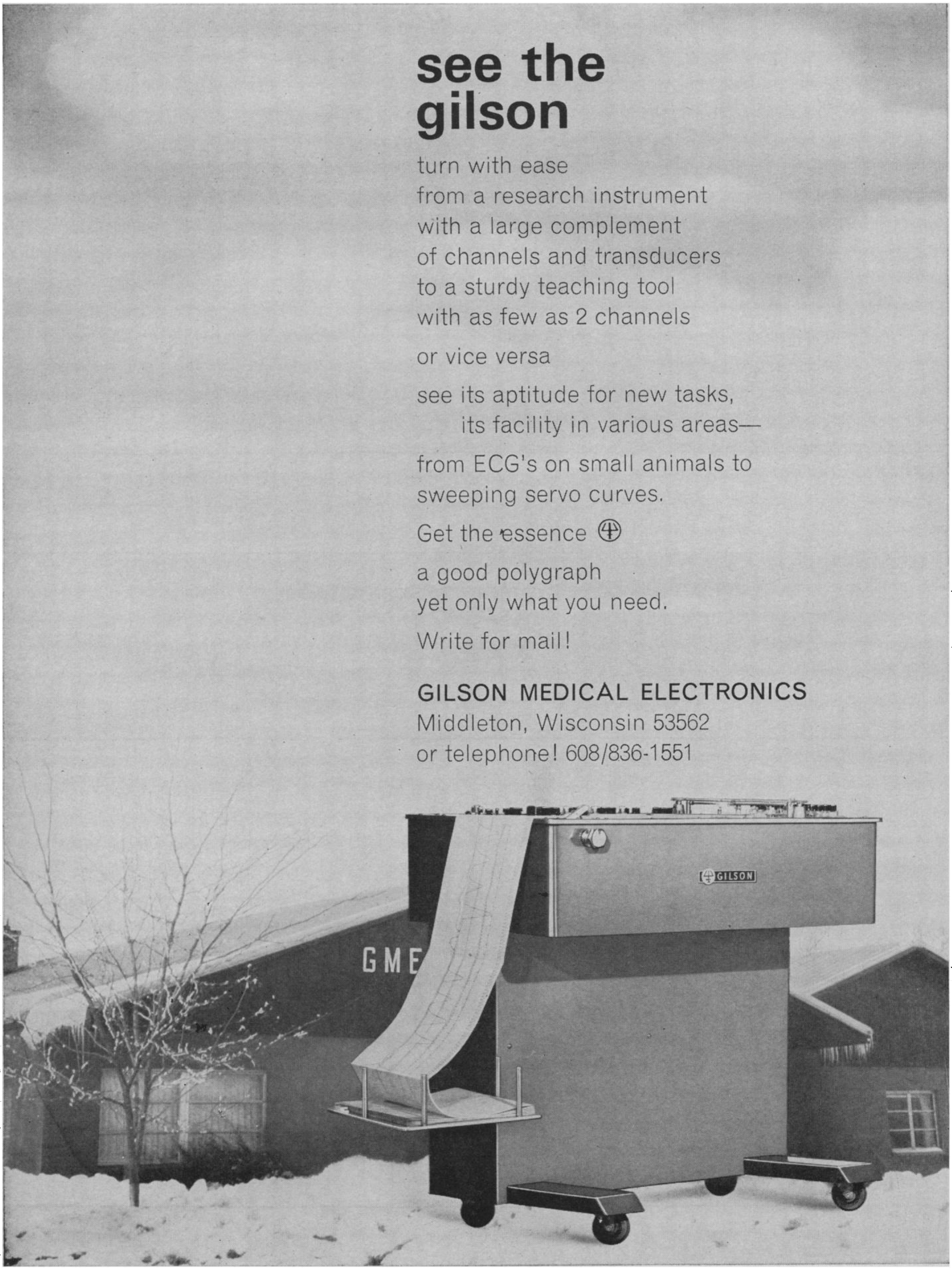
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Academic Responsibility

Many questions have arisen concerning the proper conduct of a faculty member in relation to other persons, his university, and the agencies that provide research support. Some of the worrisome questions were illustrated in the account in last week's *Science* of the summer activities of Professor Stephen Smale. On a quite different front, medical and behavioral scientists have been troubled by the disregard a few of their fellows have shown for the rights of human beings used as experimental subjects. Despite much discussion of the management of grants, problems persist. It seems likely that among all the persons whose work is supported by federal funds there are a few scoundrels who have accepted salary from two sources for the same period, or in some other fashion have violated common standards of honesty. The number who are dishonest, callous, or foolish may be small, but frequency is not the issue. It takes only a few to make a large amount of trouble, and they can continue to do so as long as the majority shrug off misbehavior as the business of someone else.

Standards are established either by government decree or through voluntary self-discipline, and both methods have their appropriate uses. Penal codes and tax rates, for example, are subject to government control, while academic standards, accrediting procedures, and codes of ethics are adopted voluntarily.

When the federal grant program started, the scientific judgment, honesty, and good sense of scientists were expected to control the ways in which money was used. Elaborate rules established by government action were not considered necessary. More recently, as the number of grantees and the amount of money involved have increased many fold, government regulations have multiplied, for informal surveillance by professional colleagues and academic or research administrators has no longer seemed to provide adequate controls.

Many scientists object to this trend. They dislike time-keeping requirements and the necessity of receiving advance permission for what their scientific judgment tells them are necessary changes in budget allocations or desirable changes in research plans. The trend toward greater government control has also been a matter of controversy in government circles. Critics have advocated stronger central controls at the same time that science agencies have argued that control should be primarily a voluntary and institutional rather than a governmental responsibility and have pleaded with universities and research laboratories to accept that responsibility. University presidents have generally understood the importance of keeping control at the institutional level. But scientists often have not, and some have failed to recognize the need that there be public confidence that public funds are used prudently and honorably. They have talked much of academic freedom without accepting the correlative requirement of academic responsibility.

Sooner or later there is going to be a messy public scandal. When that happens, the damage will be much less if the universities, with the wholehearted support of their faculties and the scientific community, can demonstrate that they have recognized the danger, have established responsible standards, and can deal promptly and effectively with violations. If they cannot, the warning is clear: government controls will grow stricter; reporting requirements will become more onerous; and the whole enterprise will suffer.—DAEL WOLFLE

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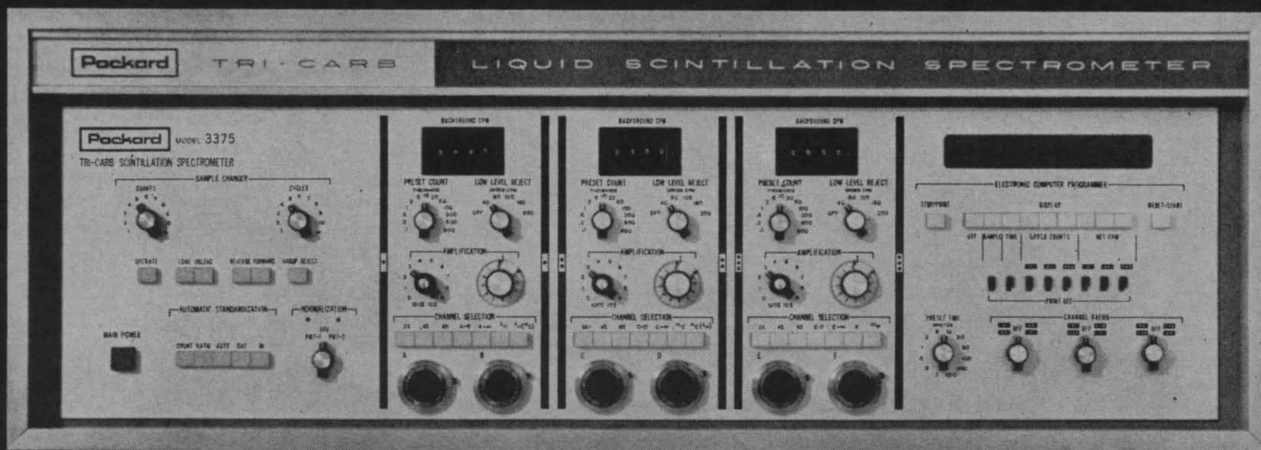

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ly 50 percent of the subjects had relapses after 15 and 10 days, respectively, of treatment.

Longer periods of treatment with tetracycline were evaluated in man. Prophylaxis with 0.5 gram of tetracycline twice daily for 28 days completely prevented illness. The same schedule for 14 days failed. Illness occurred both during and after a 20-day course of tetracycline treatment given every other day. Treatment with 2 grams of tetracycline daily, in divided doses, for 15 days or longer prevented relapses, but limiting the treatment to 10 days resulted in relapses in 42 percent of volunteers.

R. J. Zentner (U.S. Army Biological Laboratories) described studies on toxic effects of oxygen on aerosolized and on lyophilized bacteria. He reported on the threshold concentration of oxygen toxicity and suggested that the lethal effect is caused by dehydration of the bacteria.

M. T. Hatch (Naval Biological Laboratory) described the effect of another type of stress, namely, shifts in relative humidity, on airborne bacteria. The studies show that changes in relative humidity influence the survival of airborne *S. marcescens and P. pestis*. There was no indication of which rates of changes in humidity were most lethal. Hatch stressed the physiological rather than the physicochemical nature of this effect.

Experimental airborne transmission of several viral, fungal, and bacterial diseases was discussed. W. S. Miller (U.S. Army Biological Laboratories) described studies on the infectivity of Venezuelan equine encephalomyelitis (VEE) virus for pigeons by the respiratory route. He reported that this virus can infect an avian host through the lower respiratory tract but that marked differences exist among species. Subcutaneous injection produces a disease indistinguishable from the disease produced by the respiratory route. Treatment of pigeons with a combination of Casa-terramycin and Hep Zide or with Casa-terramycin alone for 2 weeks prior to exposure to the VEE aerosols reduced resistance to respiratory challenge. In his comments, W. S. Gochenour (Walter Reed Army Institute for Research) stressed the significance of the observations of the resistance of pigeons to infection when exposed to low concentrations of VEE virus, which can accumulate to a large dose over a long period of time (3 hours).

Report from

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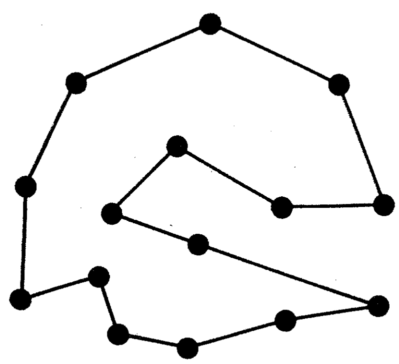
Found: A rapid route to the shortest path

The critical feature of Shen Lin's method is its speed; it makes many good approximations in a reasonable time and selects the best.

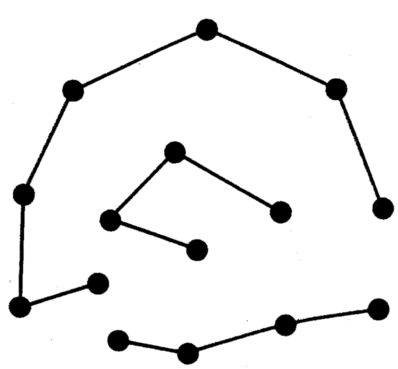
To make one approximation, the computer chooses a "starting path" at random. It removes three links of this path (thus breaking it into three sections – see figures) and connects the sections differently to see if a shorter path results. If not, it systematically removes other combinations of three links in the original random path, until all combinations have been tried. But, whenever such a reconnection *does* produce a shorter path, it takes this as a *new* starting path, and begins the series of breaks again. One "approximation" is completed when no further improvement results from such breaking and reconnection.

In the same way – beginning each time with a new and different "starting path" – many additional approximations are found. They usually have some path sections in common; it simplifies the problem to assume that these are part of the absolute minimum path. So, they are routinely incorporated into every new starting path and no longer broken. This speeds computation and the time that's saved is used to find even more approximations.

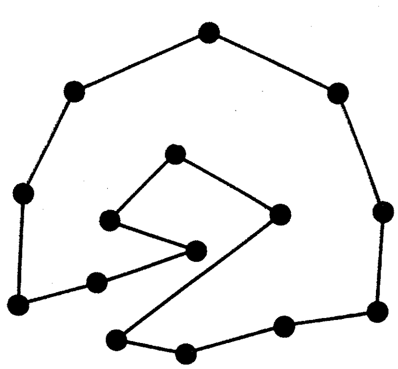
In general, using a high-speed digital computer, 100 approximations take about $0.75n^3$ milliseconds (n = number of points). For a typical 40-point problem, experiments indicate that about one out of 16 approximations will be the actual minimum solution; for 60 points, about one out of 64. So, if we find 300 approximations in a 60-point problem (roughly eight minutes on a computer) there is a high probability that one of these is the shortest possible.



Start with a random path...



Break it into three sections...



Reconnect them differently.

What is the shortest path through a number of points, touching each just once and ending at the starting point? This "traveling salesman problem" is important in many areas of modern business and technology, where "shortest path" may really mean the least hook-up wire, travel time, or transmission power.

It might seem that the problem could be solved by measuring all paths and taking the shortest but, even with a computer, this is a colossal task. At a million paths per second, for instance, it would take several billion years to compute and compare all paths in a 25-point problem! Shortcut methods have been devised, but they are still too slow when, say, 60 points are involved. In practice, approximate solutions (almost-shortest paths) are found largely through the educated judgments of engineers looking at graphs or maps . . . or for certain limited problems, through special computer programs.

Now, mathematician Shen Lin of Bell Telephone Laboratories has developed a new way of getting good approximate solutions to problems of up to 145 points. Because his method is fast, it is possible to find many such approximations. It is then easy to pick the shortest of these. Often (see left), this is the absolute minimum. If not, it is at least short enough for most engineering purposes.

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P. S. Brachman (Communicable Disease Center) presented data on exposure of cynomolgus monkeys to naturally produced aerosols containing *Bacillus anthracis.* Anthrax infection was observed in approximately 25 percent of the exposed monkeys. The pathological findings of mediastinal edema and hemorrhagic lymphogenitis and necrosis were similar to those in monkeys exposed to experimental aerosols of *B. anthracis* and also to those in humans who developed fatal inhalation anthrax after industrial or accidental laboratory exposures. With the low dose present in chronic exposure to natural aerosols, the incubation period appeared to range from 5 to 17 days. There was no evidence suggesting the development of a subclinical anthrax infection.

Epidemiology of airborne staphylococcal infection was reviewed by R. E. O. Williams (Wright-Fleming Institute of Microbiology, England) and A. D. Langmuir (Communicable Disease Center). Williams suggested that the chief way staphylococci become airborne is by shedding of particles of skin from permanent or temporary carrier sites. The magnitude and the frequency of such dispersal was discussed, together with factors that may influence it and the manner in which airborne staphylococci travel in hospitals.

Most airborne particles containing staphylococcus range in size from 8 to 18 microns in diameter, and most of them contain one to four viable cocci. The bulk of each particle presumably consists of the epithelial squame. It is difficult to obtain conclusive evidence of the way in which airborne bacteria gain access to the new host or on the relative importance of airborne and "contact" routes of spread. The possibilities of direct airborne infection of wounds in surgical operating rooms, primary acquisition of the nasal carrier state in newborn infants in hospitals, and acquisition of staphylococci in the nose in adult patients in hospitals were discussed. The difficulty in determining the relation between dose and effect and the importance of attempts to do so were stressed. Langmuir discussed in broader terms the epidemiology and the mechanisms of transmission of airborne infection.

H. M. Yamashiroya (IIT Research Institute) described aerosol vaccination with tetanus toxoid. He was able to protect guinea pigs with tetanus toxoid by using the respiratory route of vaccination. Primary aerosol immunization as well as an aerosol booster following either respiratory or subcutaneous vaccination appear to be effective procedures. H. C. Bartlema (Medical Biological Laboratory, Netherlands) achieved similar results in mice by using dead cells of *Bordetella pertussis* as an adjuvant.

Effects of nitrogen dioxide and ozone on resistance to respiratory infection were discussed by R. Ehrlich (IIT Research Institute) and D. L. Coffin (U.S. Public Health Service). The work reported suggests a more sensitive indicator of biological effects of selected air pollutants, as demonstrated by reduction in resistance to infection. A single 2-hour exposure to 3.5 ppm of nitrogen dioxide before or after respiratory challenge with *Klebsiella pneumoniae* significantly increased mortality in mice. Continuous exposure to 0.5 ppm for 3 months produced the same effect. Mortality also increased in mice exposed to less than 0.1 ppm of ozone for 3 hours before challenge with *Streptococcus* sp. Similar reduced resistance was observed after 4 hours of exposure to photochemical automobile smog.

The conference was cosponsored by the U. S. Army Biological Laboratories and the IIT Research Institute, under the chairmanship of E. K Wolfe (U.S. Army Biological Laboratories), Mark Lepper (University of Illinois), and Richard Ehrlich (IIT Research Institute). The proceedings of the conference are scheduled for publication in *Bacteriological Reviews.*

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Forthcoming Events

October

28–29. Society for **Scientific Study of Religion**, annual mtg., Univ. of Chicago, Chicago, Ill. (S. Z. Klausner, The Society, 1200 17th St., NW, Washington, D.C. 20036)

30–3. **Metallurgical** Soc. of AIME, fall mtg., Chicago, Ill (American Inst. of Mining, Metallurgical, and Petroleum Engineers, 345 E. 47th St., New York, N.Y. 10017)

31–3. American Soc. for **Metals**, 48th annual congr. and natl. metal exposition, Chicago, Ill. (The Society, Metals Park, Ohio 44073)

31–4. American **Public Health** Assoc., 94th annual mtg., San Francisco, Calif. (The Association, 1790 Broadway, New York, N.Y. 10019)