# NAS study backs pollution limits

A one-year study on the health and cost effects of air pollution, conducted by the National Academy of Sciences for the Senate Public Works Committee, concludes that present ambient air quality standards are generally supported by research conducted since they were first set up. However, the NAS scientists warn that large uncertainties still exist as to how much health damage is caused by pollution, and that much more extensive studies are needed.

The study concentrated on the effects of auto emissions. The NAS panel concluded that such emissions may account for as much as one quarter of one percent of the total urban health hazard, causing as many as 4,000 deaths and 4 million workdays lost due to illness, annually. A substantial portion of this effect is due to the extreme susceptibility to pollution of people already suffering respiratory or cardiac ailments. As much as one-fifth of the population, including the very old and very young, may be especially vulnerable to air pollution, the report concludes.

The only major revision of the standards recommended was an unspecified easing of the nitrogen oxides emission standard for automobiles. The present standard may be "somewhat more stringent than is needed" to achieve desired ambient air quality desired for $NO_2$, except in the Los Angeles area, the panel reported. It recommended more study, however, before trying to set new, lower standards.

Even this mild announcement was welcomed by the Detroit auto industry, which says it can begin work on stratified charge engines (SN: 4/28/73, p. 276) once the nitrogen oxide standards are eased. (Automakers say they have no way of meeting presently projected $NO_x$ standards, since catalytic mufflers only take care of unburned hydrocarbons and carbon monoxide, and even stratified charge engines produce nitrogen oxides above the 1978 limit.

A glance at the details of the academy report shows just how uncertain the business of estimating pollution effects remains. The panel estimated that one percent of the total urban health hazard results from air pollution of all sorts, but they cite other experts whose judgments range from a hundredth of that figure to ten times larger. Similarly, the supposed monetary loss due to adverse health effects of pollution ranges from $500,000 a year to $3 billion. The committee could conclude only that the apparent monetary benefits of less pollution and the apparent costs of emission control lie in the same ballpark (a factor of two or three, one way or the other).

The committee said that the concept of "thresholds"—pollution levels below which *no* effect would be observed—simply is not applicable, since contamination and health effects seem proportional at all levels. "There is no escape from a reasoned judgment, containing an unavoidable subjective element," stated the report. "In this respect, air quality standards do not differ from other standards established by legislation and regulation."

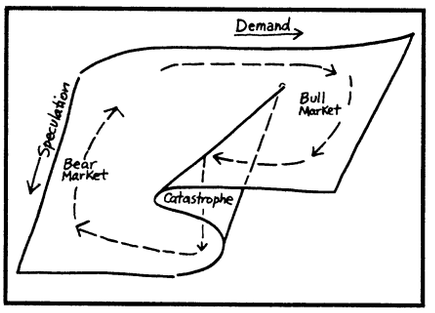
Such an ambiguous, though reasoned, conclusion was the last thing the Senators wanted to hear. Stormed Edmund Muskie (D-Maine): "What we want is some one-armed scientists" who give definite conclusions; not ones who say "on the one hand . . . but on the other hand." Committee chairman Jennings Randolph (D-W. Va.) criticized the academy for concentrating on autos while neglecting study of emissions from stationary sources (which run on West Virginia coal).

Academy President Philip Handler reminded the committee that it had specifically requested information on auto emissions, but not on stationary sources. John Seinfeld, who worked on the committee, defended the report's ambiguity by saying "we really do not know what the effects of a relaxation" of standards might be. Chairman Randolph said he had hoped to have more data on which to base modification of the Clean Air Act next year.

Specifically, the NAS report says more information is needed on how pollutants interact (synergism), how weather patterns affect their spread, and what effect they have on, say, people who smoke, as opposed to those who don't. The study follows close on the heels of a report that a majority of Americans already have carbon monoxide blood levels at or above the safe level recommended by the Clean Air Act (SN: 9/7/74, p. 148). □

# Mathematicians hail new theory

*This news report from the International Congress of Mathematicians was written by Lynn Arthur Steen, professor of mathematics at St. Olaf College, Northfield, Minn., under an experimental public understanding of the mathematical sciences project being initiated by the Conference Board of the Mathematical Sciences. Future reports from Steen may appear from time to time in* SCIENCE NEWS.




*An illustration of stock market cycles on a manifold: A bear market with sluggish demand and fleeing speculators is followed by increasing demand, then increased speculation. Once demand begins to fall, this bullish market encounters a catastrophe on the surface, abruptly dropping to a bearish mood.*

Ever since calculus was invented three centuries ago, mathematicians and scientists have found it to be an indispensable tool in explaining the continuous processes of nature. Until recently, however, they have had no comparable model for discontinuous phenomena such as the boiling of a liquid, the crash of a stock market or the discrimination of different tissues in an embryo. But now they have a very promising model for such things, in the form, roughly, of a carefully crumpled sheet of paper.

Thousands of the world's leading mathematicians, assembled last month at Vancouver, B.C., in their 17th quadrennial international congress, turned out to hear E. Christopher Zeeman of the University of Warwick outline the highlights of a major new theory that has developed in the four years since the congress last met in Nice, France, in 1970. He documented its power by an impressive variety of applications in such diverse fields as linguistics, political theory, embryology, neurology, economics, psychology, sociology and physics.

French topologist René Thom, winner in 1958 of a Fields medal for outstanding contribution to mathematics, created this new theory in a series of papers on topological models in theoretical biology. He called it the theory of "catastrophes" because it explained how a tissue (or other biological object) may suddenly, "catastrophically," jump from one form of behavior to another. The simplest model of catastrophe theory is that of a surface with a smooth pleat: As a particular process such as a bullish stock market climbs smoothly to the upper part of the pleat, it will reach a point where it may fall catastrophically to the lower part whence it may begin its slow climb once again.

Because it is based on deep results in differential topology, Thom's work is not yet widely understood. But it is being used by an enthusiastic coterie of pure and applied mathematicians, and has been hailed by reviewers as comparable in its scientific potential to Newton's *Principia* itself. Whereas Newton invented calculus in order to explain the continuous processes of nature,

Thom invented catastrophes in order to explain the discontinuous processes. Thom's theory builds on the results of 300 years' research into the manner in which continuously changing causes produce continuously changing results. But Thom succeeded in showing how continuously changing causes may produce results that exhibit dramatic discontinuities, or in his terminology, catastrophes.

There is more to the theory, of course, than pictures of folded sheets of paper. Scientists have long recognized that when two or more causative agents vary independently (temperature and pressure in the atmosphere, for example, or hostility and fear in animal behavior) the totality of all possible results can be represented conveniently by a surface with as many dimensions as the number of causative agents. Such surfaces are called manifolds and are the objects studied by differential topologists.

In developing his theory of catastrophes, Thom showed first how a manifold with an appropriate pleat can explain observed instances in which continuous causes produce catastrophic consequences. He then went on to classify all possible pleats in manifolds of low dimensions—thus providing scientists with a relatively small number of models for catastrophic phenomena together with a general proof that these models are the only possible ones. It is this latter point, contained in Thom's basic theorem on the classification of elementary catastrophes, that forms the core of the theory.

Thom showed that under certain specific but quite general circumstances, any singularity of a function on a manifold is equivalent to one of a few basic types called "elementary catastrophes." In a two-dimensional manifold (representing two interacting causes) there are just two possible types of catastrophes —a fold-catastrophe which may occur at the boundary of the manifold, and a cusp-catastrophe caused by a pleat on the surface of the manifold.

In 3, 4 and 5 dimensional manifolds there are, respectively, 5, 7 and 11 possible elementary catastrophes. Since these cases are quite difficult to visualize and interpret, Zeeman's Warwick colleagues Tom Poston and Ted Woodcock have developed computer graphics to illustrate the higher dimensional catastrophes.

One curious feature of Thom's classification theorem is that when the number of dimensions (the number of causative factors) reaches 6, the number of possible elementary catastrophes becomes infinite. As the number of dimensions increases, so does the space available in the manifold. Eventually the manifold contains enough room for the elementary catastrophes to evolve continuously from one to another. □

# Mariner 10 returns to Mercury

Since March 29, when Mariner 10 flew by the planet Mercury, Mariner has almost completed a full journey around the sun, while Mercury has been around almost twice. On Sept. 21, spacecraft and planet will meet once again, although a mishap aboard the probe last week has strained the chances of a third encounter in the spring.

Unlike the first flyby, the September meeting will take place along Mercury's brilliantly sunlit side (SN: 7/6/74, p. 9), which will both enable photography of the south polar region of the planet and trim the spacecraft's trajectory for a third pass next March. The probe is expected to pass slightly less than 48,000 kilometers from the planet, much farther out than the 689 kilometers that separated them last March, but it should increase photo coverage of the sunlit side to 60 percent, as well as providing better viewing angles of areas already photographed. The only other of Mariner's instruments to scan the planet during the encounter will be an ultraviolet airglow detector seeking traces of hydrogen, helium, oxygen, neon and carbon in the thin atmosphere.

What worries flight controllers at Jet Propulsion Laboratory in Pasadena is that the spacecraft may run out of gas before it can come around a third time. Last Wednesday, an uncontrolled oscillation in the circuit that stabilizes Mariner on its roll axis caused the stabilizing jets to expend 0.54 pounds of the remaining 1.8 pounds of control gas. This should not affect the upcoming encounter, but will make things tight for the spring meeting. A previously developed solution involving orienting the spacecraft in a certain position (SN: 5/18/74, p. 319) was only partially applicable this time, and although a flight official estimates that next year's encounter could be accomplished on as little as 0.8 pounds of gas, a "strict conservation strategy" will be in force all the way. □

# Searching out typos by computer

First newspapers and printing houses used computer tape to eliminate hand typesetting. Then they put in cathode ray terminals to eliminate hand copy-editing in the newsroom and hooked these to the computer tape operation. Now, Bell Labs of Murray Hill, N.J., has developed a way to computerize the proofreading operation and hook up all three.

By using standard medium-sized computers—found with increasing frequency in the publishing business—a 100-page book or a complete newspaper could now be proofread for misspellings and typographical errors in about three minutes. Two Bell researchers, Robert Morris and Lorinda L. Cherry, developed a special computer program to carry out this function for the Bell system's own extensive writing mill of in-house books, pamphlets and technical reports.

The system is fairly simple. The text is entered directly into the computer, either through a teletype machine or a cathode ray terminal (a television screen on which words appear as the author writes on a keyboard.) The computer then rapidly breaks each word into all of the possible two- and three-letter combinations and compiles them into a table of common word segments used in the article. It stores this in its memory—and one second has passed by. The computer then rescans the entire document and compares each wrong whole word to the table and assigns to each an "index of peculiarity." Two seconds. Then the computer prints out a list of the peculiar words in the order of their peculiarity, with the strangest one at the top—three seconds.

*Cathode ray screen shows word list and computer-assigned index of peculiarity.*

The author or proofreader now has a list of words to check for corrections, but does not know or need to know how many times each appeared or where they appeared in the text. He instructs the computer to correct each word wherever it appears, sends the document through one more time, and is finished.

The computer program will not catch punctuation or semantic errors, but should cut total proofreading time tremendously, a Bell spokesman says, and should be useful to large publishing concerns with electronic equipment. □