Noise: The unseen pollution

Forty million persons in the United States may be exposed to potentially hazardous noise

by Richard H. Gilluly

As Barry Commoner of Washington University points out, "everything is connected to everything else." The problem of noise pollution is no exception. For instance, another feature of modern civilization, high-cholesterol diets, may be related to how people react to noise. And whether people can adjust psychologically to high noise levels depends to a certain degree on their attitude toward the noise and its source.

A recent report on noise pollution by the Environmental Protection Agency "waffles" a good deal on the subject, an EPA official acknowledges. This is presumably because its more startling conclusions scared the Office of Management and Budget (which must allocate the Federal share of funds for noise-pollution abatement) into insisting the conclusions had to be toned down. According to AIR AND WATER NEWS, OMB shifted some of the more startling data from a prominent part of the report to an "obscure place."

With the help of the EPA official, SCIENCE NEWS found the "obscure place" in the voluminous report. Here is what it says: "The data show that approximately 22 million to 44 million people have lost part of the utility of their dwellings and yards to noise from traffic and aircraft on a continuous basis, and another 21 million at any one time are similarly affected by noise from construction activity. Further, many people are exposed to potentially hazardous noise while operating noisy devices. Although the number exposed to potentially hazardous noise cannot be accurately assessed . . . a total of 40 million people might be reasonable."

It continues: "Thus, not including the contribution of appliances, noise appears to affect at least 80 million people, or 40 percent of the population. Roughly one-half of the total impact of noise represents a potential health hazard (in terms of hearing impairment potential alone), and the remaining half represents an infringement on the ability to converse in the home." In many instances, says the report, the noise can be controlled with little difficulty. An article in the February ENVIRONMENTAL SCIENCE AND TECHNOLOGY and a recently published book, *Noise Pollution*, by Clifford A. Bragdon of the Georgia Institute of Technology (University of Pennsylvania Press) back up this conclusion—although all three suggest that noise abatement will not often be free.

Part of the problem in abating noise, says Bragdon, is the notion that noise is the price of otherwise desirable progress. If large numbers of people have this attitude abatement will be difficult. On the other hand, psychological data tend to show that people with this attitude may actually suffer less from the noise; if they accept it, they are less rattled by it (SN: 1/1/72, p. 6). Such data furnish ammunition to those who would counsel a go-slow attitude on abatement. But, counter the opponents of such a view, it is society's duty to protect all its citizens, including those who have the misfortune of disliking noise. If one sector of the population insists on its freedom, say, to ride jet aircraft or motorcycles then another sector certainly has a right to insist on freedom from the noise created by the former. And when noise reaches actual physiologically damaging levels there seems little doubt about society's duty to provide protection.

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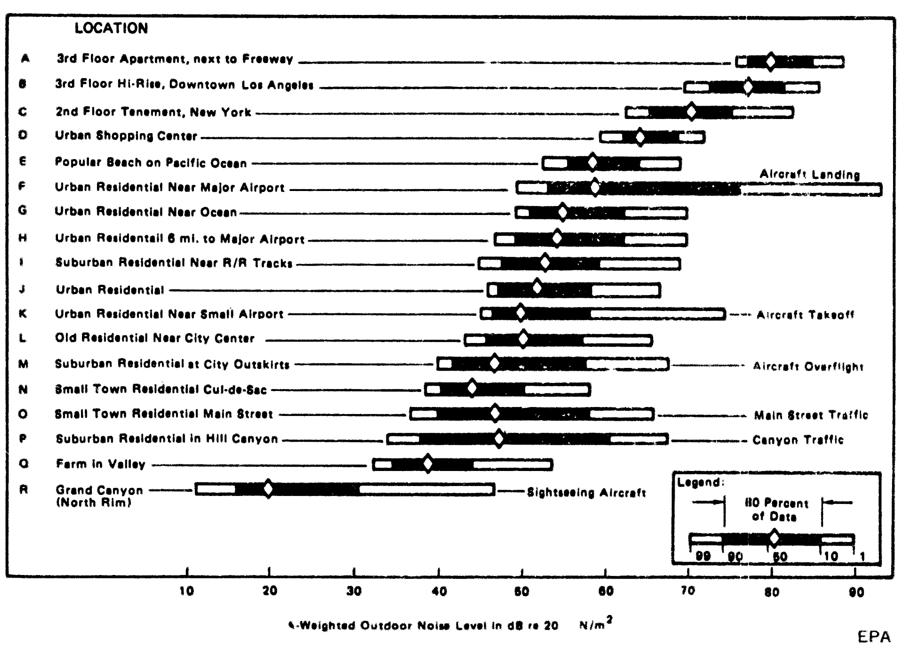
The complexities of noise pollution come right at the beginning, in providing a definition of noise. Gross noise is measured in decibels (dB), a figure obtained for any given sound by computing a logarithmic ratio of the sound's pressure to the pressure of the weakest audible sound that can be perceived by a young ear. Thus a zero-decibel rating is given to a sound that creates a pressure of 0.0002 microbars (the lowest audible sound). Decibel numbers are then assigned to sounds of ascending pressure up to 140 decibels for a sound with a pressure of 2,000 microbars. Because of the logarithmic formula, increases are geometric: 60 decibels represent sound energy a million times as intense as zero decibels; 80 decibels represent sound 100 times as intense as 60 decibels.

But decibels express gross noise, including frequencies not perceived by the human ear. Thus three "weighting networks" have been formulated, the A, B and C networks. Each describes dB according to the frequency range it includes. The A-scale most closely corresponds to the frequencies heard by the human ear and thus is the most frequently used one. The abbreviation "dBA" is used to express A-weighted decibels.

But the new EPA report says A-weighting is imperfect for measuring noise that affects human beings, because it does not take into account that certain noises—such as the whine of a jet—are "noisier" to the human ear than other sounds of the same intensity but of a different frequency. To account for this anomaly, audiologists have come up with another concept: the "tone-corrected Perceived Noise Level." Because uniform acceptance of one scale over another has not yet occurred, there is no consistent use in the literature. Thus in this article, all three will be used, depending on who is quoted: Gross decibels, A-weighted decibels and Perceived Noise Level decibels (PNdB).

The next problem is to relate levels of sound to their effects on human beings. Once again, the problem is complex. For instance, a certain level of noise only mildly annoying during the day might be extremely disruptive during sleeping hours. Ordinarily, says



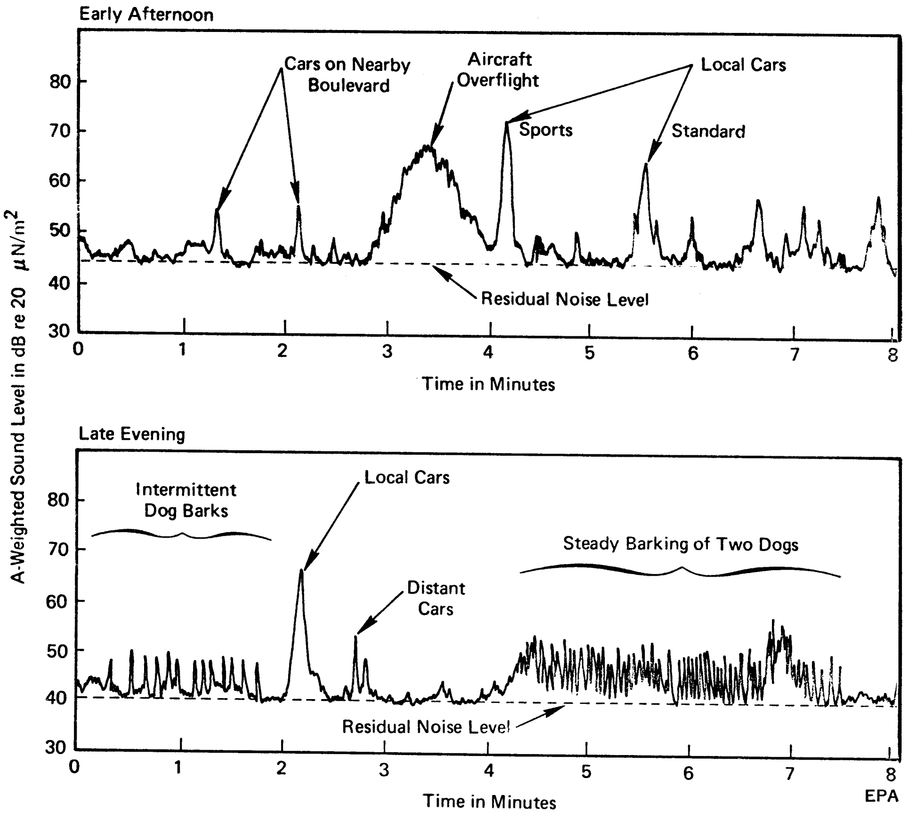
EPA

Bragdon, the threshold at which noise begins to interfere with the performance of tasks—by causing increased errors in observation, impaired time judgment and difficulty in remaining vigilant—is 90 dB. But sleep experiments have shown that the sleep level is altered by exposure to traffic noise as low as 55 dBA.

It is generally agreed that physiological hearing damage (SN: 1/31/70, p. 132) begins at exposure to 85 dB. The damage depends on length of exposure and frequency characteristics. The damage is manifested in permanent or temporary "threshold shifts," in which the ability to hear sounds at lower levels is impaired. Temporary shifts, if repeated frequently enough, says the EPA report, can result in permanent shifts. Obviously, the higher the noise levels and the longer the years of exposure, the more likelihood of permanent shifts. Sometimes permanent shifts can result from a single, traumatic noise, such as gunfire, firecrackers or hammering on metal. At lower than single-trauma noise levels, says EPA, there is a direct relationship between levels of noise and the severity or extent of hearing damage. ". . . It is estimated that the percentage of people who may develop a hearing handicap as a result of exposure of 20 years to a noise level of 95 dBA would be approximately twice the number exposed to 90 dBA for 15 years."

Noise causes hearing damage by impairing or destroying the organs of Corti, receptor organs in the inner ear. A single traumatic sound can produce vibrations in the organs so intense that it is torn apart. Less intense, but severe, noise can interfere with cellular processes in the organs and cause their eventual breakdown. Prolonged lower levels of noise can produce injury through forcing cells to work at too high a metabolic rate for too long a period. Once the damage is done, the various kinds of injuries amount to the same thing; the cells are not capable of regeneration.

Damage from noise levels below 85 dBA, the threshold of physiological damage, is much more difficult to assess, but perhaps not as difficult as the EPA report sometimes suggests. "Whether sleep disturbance by noise constitutes a health hazard is debatable," says the report. "Normal" persons who lose sleep may compensate by spending more time in deep sleep or napping, it explains. But just who is to define "normal" is left open, and the report admits that a variety of factors can play a role in a person's reaction to noise disturbance during sleep. These include the fluctuation of intensity of the noise, the amount of accumulated sleep, previous sleep deprivation, the person's age and sex, and psychological factors.



Noise is virtually ubiquitous in modern society. EPA furnishes graphs showing noise patterns in an "average" suburban neighborhood at various times of the day (see the above illustration). The levels are sometimes high enough during the day to interfere with conversation. At night, levels are sometimes high enough to interfere with sleep.

But the graph depicts only part of a single day in a single neighborhood. Other noises can occur. These may be occasional in some neighborhoods or frequent or constant in less fortunate ones.

EPA catalogued these other noises in terms of decibel exposure to the persons riding in or using the machines causing the noise. The noise exposure could be nearly as great, in some instances, for helpless bystanders or neighbors, depending on their distance from the machines. For instance, in the same neighborhood on a Saturday morning, a neighbor might mow his lawn with an internal-combustion lawnmower; his exposure would be 87 dBA. A motorcycle might pass, exposing its rider to 95 dBA. Chain saw noise is as high as 100 dBA. All such noises are high enough to cause hearing loss after sufficient exposure.

And some places there *is* sufficient exposure. William C. Meecham of the University of California at Los Angeles reports that some 70,000 Inglewood residents who live near the Los Angeles International Airport are regularly subjected to 90 dB. Pacific Palisades, Santa Monica and Beverly Hills, although farther from the airport, still regularly get 65 to 75 dB. Residents of a central city, or suburbanites near a freeway, might get construction or truck noises regularly as high as 90 dB. Someone unfortunate enough to live within 1,000 feet of where four-engine turbofan aircraft are taking off might regularly be exposed to 105 PNdB.

Noise can be controlled. Meecham, for instance, proposes a six-point program for control of jet noise in Los Angeles. It includes reducing flights, altering the flight paths for takeoffs and landings outward over the ocean, producing quieter jet engines, and building a new airport in the less populated desert area. Meecham believes a five percent increase in airfare would make the changes possible. "I see no reason why the 10 percent of our people who fly more than sporadically for business or pleasure shouldn't pay a little more to reduce the annoyance, frustration and psychological damage that jet noise imposes on the other 90 percent."

Quieter jet engines are being produced, both by use of retrofit packages for existing engines and wholly new engines designed for noise reduction. The National Aeronautics and Space Administration's acoustically lined nacelle program is an example of the first category; another such program is expected to produce retrofittable packages by 1972. NASA is also working on a new turbofan engine that will significantly reduce approach and takeoff noise. It may be commercially feasible by 1973.

Noise control strategies listed in the ES&T article (by Peter A. Franklin and Daniel G. Page) include mufflers, sound-absorptive enclosures and design modifications for internal-combustion engines (the largest single source of noise complaints); isolation, through building modifications, of residential noise, such as that caused by TV sets and radios; mufflers and sound-proof enclosures for construction machinery, and alteration of routes taken by noisy mobile equipment or alteration of the sites of noisy stationary equipment.

There seem to be two possible approaches to securing the necessary changes. With noise imposed on citizens involuntarily, outside enforcement is necessary. On Feb. 29 the House voted 356 to 32 to give EPA the power to set stringent standards for noise from all new products, and the bill is likely to fare well in the Senate. It would control construction and transportation equipment, motors and engines, electrical and electronic equipment.

The other approach is public education. Bragdon points to the widespread mystique in the United States which says that a mechanical device is not efficient unless it is noisy. Vacuum cleaner companies, he says, have failed to sell new, quieter vacuum cleaners, because housewives will not believe they work as well. Motorcyclists often remove mufflers so they can have a greater feeling of power. And everyone is familiar with the impatient motorists who honk their horns unnecessarily in traffic. Enforcement of anti-noise ordinances is sometimes the answer to such problems, although that is often difficult if not impossible. More important is to create a widespread consciousness of the harm of excessive noise.

And more research needs to be done on the effects of noise. Researchers have already discovered numerous physiological (or psychosomatic) effects beyond damage to the organs of Corti. For instance, constriction of blood vessels is caused by noise as low as 90 dB, and in residents of modern civilizations the constriction lasts longer than among residents of simpler societies—perhaps reflecting lesser elasticity in the blood vessels of the former group (SN: 1/31/70, p. 132). Various kinds of noises have produced significant changes in the endocrine system, such as increased secretion of the pituitary hormone, oxytocin, or of adrenaline. ". . . The effects of sound," says John L. Fuller of the Jackson Laboratories in Bar Harbor, Me., "are insidious and not easily detectable." □

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MATHEMATICS MADE DIFFICULT—Carl E. Linderholm—World Pub. Co., 1972, 207 p., illus., $6.95. Mathematician's entertaining introduction to mathematical thinking about problems in arithmetic, factors and fractions, algebra, topology and geometry.

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THE MOVING CONTINENTS—Frederic Golden—Scribner, 1972, 124 p., photographs, drawings by Ingrid Niccoll, $6.95. A succinct and clear presentation of the findings about continental drift and the research that established these facts.

NEW DIRECTIONS IN ATOMIC PHYSICS, Vol. 1: Theory. Vol. 2: Experiment—Edward U. Condon and Oktay Sinanoglu, Eds.—Yale Univ. Press, 1972, 250 p., 163 p., diagrams, $12.50, $7.50. Topics are covered in depth, they include second quantization and modern group theory, electron correlation and relativistic effects in atoms, atomic beam developments, and applications in astrophysics.

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PLASTICS AND RUBBERS—Edward W. Duck—Philosophical Lib., 1971, 110 p., photographs, diagrams, tables, $10. A condensed outline of the characteristics of polymers, the structure of plastic and rubbery polymers, polymerization reaction, plastics and rubber technology, and composite materials.

PROGRESS IN HUMAN NUTRITION: Symposia, Vol. 1: Biochemistry and Nutrition on Proteins and Biocatalysts. Dysnutrition in the Seven Ages of Man—Sheldon Margen and Nancy L. Wilson—Avi Pub. Co., 1971, 228 p., illus., tables, $15. Papers cover both analysis of malnutrition in developing countries and description of undernutrition in the United States.

RABIES: Proceedings of Working Conference on Rabies sponsored by the Japan-United States Cooperative Medical Science Program—Yasuiti Nagano and Fred M. Davenport, Eds.—Univ. Park Press, 1972, 406 p., illus., $18.50. Topics range from last rabies outbreak in Japan, nature and properties of rabies virus, pre- and postexposure prophylaxis, and rabies immune globulin of human origin, to field control of animal rabies.

RECENT ADVANCES IN HUMAN TUMOR VIROLOGY AND IMMUNOLOGY—Waro Nakahara and others, Eds.—Univ. Park Press, 1972, 590 p., micrographs, diagrams, $34.50. Symposium papers and discussions on problems of RNA virus, mechanism of Herpesvirus infection, research on nasopharyngeal cancer, EBV-induced membrane antigens, and factors of cell-mediated immunity.

SI CHEMICAL DATA—G. H. Aylward and T. J. V. Findlay—Wiley, 1972, 130 p., tables, paper, $3.50. Reference source based on international system of units, contains data on fundammental constants; common conversion factors; properties of elements, inorganic, and organic compounds; shapes of molecules and ions; thermochemical data at 25°C; latent heats; and other data.

TECHNOLOGY AND SOCIAL CHANGE—Wilber E. Moore, Ed.—Quadrangle Bks., 1972, 236 p., $6.95; paper, $2.45. Articles selected from The New York Times.

WORLD DYNAMICS—Jay W. Forrester—Wright-Allen Press, 1971, 142 p., diagrams, $9.75. Describes computer models of the worldwide stresses resulting from mutual interplay of demographic, industrial and agricultural subsystems, and analyzes various conclusions based on this system of global dynamics, in search of a global equilibrium.

TEXTBOOKS

FOUNDATIONS OF CLIMATOLOGY. TECHNOLOGY OF CLIMATOLOGY—E. T. Stringer—Freeman, 1972, 586 p., 539 p., diagrams, maps, $17.50 each. The two volumes offer comprehensive treatment for reference. FOUNDATIONS gives detailed introduction to physical, dynamic, synoptic and geographical climatology. TECHNIQUES provides thorough grounding in applied atmospheric science for the advanced student of both climatology and meteorology.

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MECHANISMS IN ORGANIC CHEMISTRY—Roger W. Alder, Ray Baker and John M. Brown—Wiley-Interscience, 1971, 378 p., diagrams, $13.75. Advanced-level text deals with the mechanisms of reactivity; dissociate processes; synchronous, multicenter and associative reactions, and nucleophilic associative reactions.

PRINCIPLES OF ANIMAL PHYSIOLOGY—James A. Wilson—Macmillan, 1972, 842 p., illus., $14.95. Comprehensive text presents basic concepts of animal functioning, from the cellular to the whole animal level including organ system operation. Themes of regulation and comparative physiology serve to unify the presentation.

PSYCHOLOGY, THE HYBRID SCIENCE—Frank B. McMahon—Prentice-Hall, 1972, 629 p., photographs, drawings, $9.95. Introduces in a unified manner the major viewpoints in psychology, from experimental science, perceiving and learning, concepts of personality, to group behavior and abnormal behavior.

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