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Editor of *News Report*: Barbara Jorgenson
Assistant Editor: Pepper Leeper
Staff Writers: David Jarmul, Gail Porter, Judith Rensberger
Production Associate: Patricia Worns

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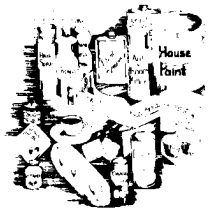
STUDIES



Finding the Bad Actors in a World of Chemicals
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Artist: Antonia Walker

". . . of tens of thousands of commercially important chemicals, only a few have been subjected to extensive toxicity testing and most have scarcely been tested at all."

Finding the Bad Actors in a World of Chemicals

by Pepper Leeper

CHEMICALS SURROUND the average American. A typical day is likely to start with a cup of decaffeinated coffee and a slightly charred slice of toast spread with hydrogenated vegetable oil and end on a mattress filled with synthetic fiber. In between, Mr. or Ms. Doe may drive a car fueled with refined petroleum, handle paper and ink processed with chemicals, eat food grown with the aid of fertilizers and pesticides, swallow vitamins or prescription drugs, apply aftershave or cosmetics, or drink an artificially sweetened beverage.

More than 5 million chemicals have been described in the chemical literature. A few are known to be hazardous to humans; an overwhelming majority of them probably are not. But identifying which is which and determining the severity of the risk so that exposure to the most toxic substances can be controlled is a gigantic task that will occupy toxicologists for many decades. In fact, new chemicals are being developed so rapidly that there will

Toxicity Testing: Strategies to Determine Needs and Priorities. Steering Committee on Identification of Toxic and Potentially Toxic Chemicals for Consideration by the National Toxicology Program, Board on Toxicology and Environmental Health Hazards (1984, 400 pp.; ISBN 0-309-03433-7; available from National Academy Press, $22.50).

probably never be a time when information is available on the toxicity of every chemical in use.

The awesome responsibility of selecting and testing potentially toxic chemicals has been assigned to the National Toxicology Program (NTP), a federal agency established in 1978 within the Department of Health and Human Services. Federal agencies such as the Environmental Protection Agency or the Food and Drug Administration, state governments, universities, industries, and individuals propose some 500 candidate chemicals a year. NTP reviews the data and decides which chemicals should be tested further and what tests would increase understanding of the hazards.

To assist it in developing a process for handling so many chemicals, the NTP turned to the Research Council. A study committee began work in 1980 and recently completed its third and final report. The committee organized into a steering committee and three subcommittees to handle different parts of the study.

Many Gaps in Knowledge

After collecting and reviewing the toxicity data available for a sample representing most of the chemicals in common use, the committee concluded that "of tens of thousands of commercially important chemicals, only a few have been subjected to extensive toxicity testing and most have scarcely been tested at all."

For many years, certainly since adoption of the Toxic Substances Control Act in 1976, common wisdom has held that very little is known about most widely used chemicals. The committee's search for data has documented this assumption.

Chairman of the Research Council steering committee James L. Whittenberger, a specialist in environmental medicine with the Southern Occupational Health Center, University of California, Irvine and Los Angeles, was not surprised by the findings. "The study quantified what we strongly suspected. Scientists in the field usually could not find the information they needed."

Other members of the steering committee agreed. "For the first time we have numbers and scientific estimates of the need instead of global, fuzzy estimates," John Doull, a toxicologist with the University of Kansas Medical Center and a subcommittee chairman, said. "Now we know where we're at."

Physician and pathologist Arthur Upton of the Institute of Environmen-

tal Medicine, New York University Medical Center, and another subcommittee chairman, observed that "the report brings out forcefully the paucity of information about the toxicity of most chemicals — and there are enormous numbers in environmental use. We know almost nothing about the majority of them."

John C. Bailar, a physician and biostatistician with the Harvard School of Public Health, also saw "substantial significance" in the report's highlighting the magnitude of the problem. "There is an enormous task facing us despite the best efforts of toxicologists and others to keep ahead," he said. The volume of work remaining does not negate what has already been done, he explained. That work has been "well-targeted" and some of it has been "superbly done," he commented.

Data on human exposure are even harder to find than data on health hazards. "You can't do a proper risk assessment without both types of information — biological effects on the human body and the amount of human exposure," Whittenberger pointed out. "We were able to get very little information on human exposure."

"There is an enormous task facing us . . ."

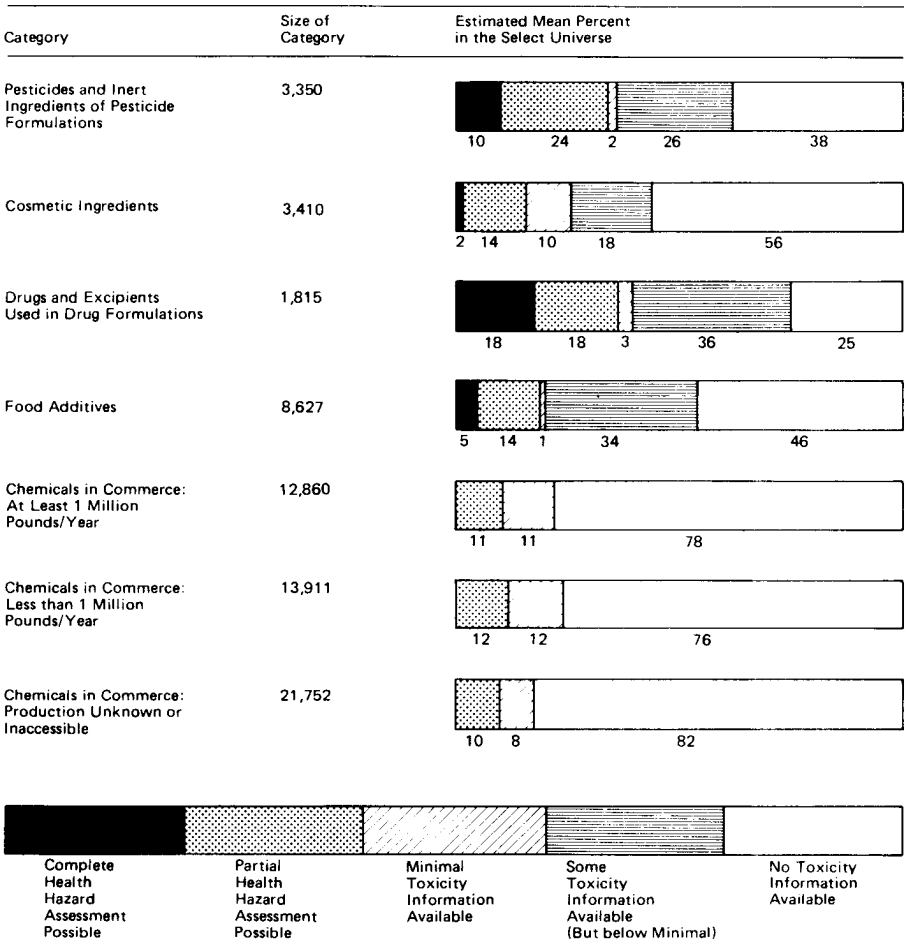
The report describes the need this way: "On the great majority of the substances, data considered to be essential for conducting a health-hazard assessment are lacking." The committee concluded that "substantial testing or retesting remains to be performed for all categories of substances."

Pesticides, Drugs Most Tested

Specifically, the committee found that pesticides and drugs have undergone the most testing. Complete health hazard assessments are possible for about 10 percent of pesticides and 18 percent of drugs and the inert ingredients mixed with them (see figure p. 7).

However, even in these much-tested groups, the unknowns outweigh the knowns, leaving 38 percent of pesticides and 25 percent of drug ingredients without any available data.

Least is known about the large numbers of chemicals in commerce — substances listed in the Toxic Substances Control Act inventory that do not fall in any other categories. Minimal toxicity information exists for only about 20 percent, while practically nothing is known about the hazards of exposure to the remaining 80 percent. The committee also found no relationship between the amount of chemical production and testing.



Ability to conduct health-hazard assessment of substances in seven categories of select universe.

"Chemicals in commerce produced in quantities of 1 million pounds or more . . . have not been tested more often or more adequately than those produced in smaller quantities," the committee pointed out.

Another phase of the committee's work involved evaluating the quality of the data available. The committee found that the simpler, more straightforward tests for acute effects—eye and skin irritation and oral administration in rodents, for example — were more often of higher quality than were the more complex chronic tests. Frequently, the committee reported, important but difficult tests of central nervous system, reproductive, or genetic damage were not performed at all.

Furthermore, of 664 toxicity tests evaluated, the committee judged only 27 percent acceptable.

"The committee adopted very stringent standards," Doull pointed out. "We were very critical."

The committee's search for and evaluation of data ended in the realization that not very much is known. But Emil A. Pfitzer, a toxicologist with Hoffmann-LaRoche Inc., Nutley, N.J., and Doull's vice chairman, thinks the exercise produced a useful tool for NTP. By identifying testing needs, the committee has developed a valuable data base that can be modified and revised as additional data become available or as judgment about test procedures change.

"This is important," said Pfitzer, "because all data were not available to the study and because scientists may differ in their judgment about testing procedures." This listing, he added, is "a significant strength" of the report.

Priority-Setting System

Tackling the roster of chemical unknowns is like trying to load a ton of grain with a teaspoon. The prospect is overwhelming. Noted the committee: "The number of commercially used chemicals far exceeds that which can be evaluated at any one time for potential toxicity with available methods and resources."

To extract the greatest return from its limited resources, NTP must be sure that the worst chemical actors are tested first and that the tests are the right ones to elicit the data needed. Duplicate or unnecessary tests waste money. These decisions are particularly important because testing is expensive, the committee said, noting that a lifetime bioassay of one chemical could cost up to $1 million.

The main objective, Whittenberger explained, is "to avoid surprises — to learn in advance about potential hazardous effects and not have another chemical come along like PCB, which we learned about long after the fact."

Traditionally at NTP, decisions have been based on expert judgment — and this must continue, the committee said. "Simply put, not enough is known about chemical hazards to specify a purely mechanical system." But the committee advised that human judgment be reserved for the end of the process and that an automated procedure be employed for initial screening of data banks related to the universe of chemicals.

"An ideal system would be capable not only of dealing with a relatively small number of chemicals nominated to NTP by agencies — as in current practice — but also of dealing with a much larger number of chemicals in the total select universe of concern," the committee declared. It proposed a four-stage process as "a plausible extension of [NTP's] current practice" and suggested a pilot demonstration to kick off the changes.

Upton thought this approach would prove to be helpful to NTP. "Our recommendation was that in theory NTP can scan the universe systematically," he said. "In the current method of selection there is no systematic effort to look at the whole universe of chemicals."

"The committee's classification of chemicals by their intended use will aid NTP by making it possible to channel priorities for further testing into areas of greatest need," Pfitzer pointed out.

Getting a Handle on the Study

With 5 million possible chemicals to choose from, the committee's first hurdle was to select a manageable list of representative chemicals. Drawing on registers prepared by several regulatory agencies, the Bailar subcommittee compiled a list of 65,725 chemicals in seven categories: pesticides, cosmetics, drugs, food additives, and chemicals in commerce. The latter category was divided according to annual production figures, i.e. 1 million pounds or more, less than 1 million pounds, or production unknown. From this "select universe," the committee drew a sample of 675 chemicals and eventually a random subsample of 100 chemicals for which at least a minimum amount of toxicity data were available.

A manageable subsample in hand, the Doull subcommittee went to work to determine how much information already is known about the toxicity and exposure levels of the chemicals and how much more testing needs to be

done. To accomplish this, they searched the literature and collected data on each substance. Working in tandem with the Bailar group, they estimated the number of chemicals for which no data exists. This group also evaluated the quality of toxicity tests used to generate the data.

Finally, the Upton subcommittee developed the four-stage process that NTP might adopt for screening chemicals and setting priorities for testing.

"The committee examined many priority-setting systems," Whittenberger said, "but decided it could not recommend a single system."

Public Significance

But what does all of this mean to Mr. and Ms. Doe, who continue to ingest, inhale, and absorb thousands of chemicals in their everyday activities?

Initially, it will make little difference. However, over time, the committee's recommendations may facilitate NTP's task so that more suspect chemicals are tested for toxicity. As more is learned about environmental hazards, decisions can be made from a base of knowledge either to limit use of a dangerous substance or to tolerate a minimal risk because of overriding benefits. Society is faced with just such a quandary in the use of nitrite-cured meats; the nitrite may promote cancer, yet it also protects against botulism.

The report has revealed "a very real concern," Whittenberger said. He expressed the hope that the study would improve NTP's testing of chemicals suspected of endangering the public's health. Eventually, the environment should become safer for everyone.

"I hope the people take these findings to heart and that we begin to fill in some of the huge gaps," Bailar said. "We need an overall substantial expansion of support, and now we can tell the public how big the task really is."

Groundwater Contamination: Prevention Beats Costly Cleanups

by Judith Rensberger

LIKE TIMES BEACH AND LOVE CANAL, the case of Colorado's Rocky Mountain Arsenal is an environmental horror story. Thirty years of dumping chemical wastes into leaking evaporation ponds have poisoned the groundwater for miles around, ruined crops, sickened livestock, and threatened public health. What makes Rocky Mountain Arsenal a bit different, however, is that it is also the site of a massive, state-of-the-art cleanup. The ambitious pilot program in "restoration" was said at one point to be proceeding "successfully," with the amount of contamination "significantly diminished."

But recent estimates indicate that containment of toxic wastes at the arsenal—that is, merely holding the line and keeping the contamination from getting any worse — will cost at least $100 million, and the cost of total decontamination could easily exceed $1 billion.

"The question of cost benefit trade-offs to society in these cases needs to be examined carefully," a Research Council report on groundwater contamination points out; "some sites may prove to be so expensive to restore that they may have to be designated as permanently contaminated."

The Research Council committee's report grew out of a December 1981 symposium on groundwater contamination. The Rocky Mountain Arsenal and six other well-documented examples of groundwater contamination were selected for detailed study because they illuminate particular scientific problems in contaminant flow, waste disposal, and aquifer reclamation. Each case

Groundwater Contamination. Geophysics Study Committee, Geophysics Research Forum (1984, 192 pp.; ISBN 0-309-03441-8; available from National Academy Press, $17.95).

study is presented in an individually authored chapter in the report. The committee's own conclusions and recommendations are presented in a separate overview chapter.

Wastes Threaten Groundwater

The Rocky Mountain Arsenal is only one of 50,000 sites that have been used at some time for disposal of hazardous wastes. The U.S. Environmental Protection Agency has determined that 1,200 to 2,000 of them may pose a threat to the environment, and that more than 400 definitely do.

The disposal of liquid and solid waste is not the only cause of groundwater contamination, the Research Council report points out. A growing concern is the cumulative impact of smaller but more numerous "nonpoint" and "small point" sources such as domestic septic tanks, accidental industrial spills, and the intensive use of fertilizers, herbicides, and pesticides. The report cites estimates that between 0.5 and 2.0 percent of the groundwater in the United States may already be contaminated. Though the proportion is small, much of it is in the regions of heaviest reliance on groundwater.

These facts underscore the urgency and importance of what the Research Council report identified as the number one challenge — to prevent groundwater contamination in the first place.

It can be done. Although waste disposal poses the greatest threat to groundwater, the report states, contamination is not inevitable. "The subsurface can be used for waste repositories," the report states flatly. "If done with care, toxic wastes can be isolated from the biosphere for periods so long that they can be measured in terms of geologic time." The report suggests searching for disposal sites more diligently, investigating them more carefully, and segregating one type of waste from another.

Toxic Liquids Enter Aquifer

Rocky Mountain Arsenal's history of environmental degradation began in 1942 at a U.S. Army facility just outside Denver. Protecting groundwater was not the priority of the moment; the war effort was, and at the arsenal that meant manufacturing poison gases for use in chemical warfare. Later, a private chemical company leased the facility to make insecticides. The wastes from these operations—a toxic soup of complex organic and inorganic chemicals—went into an unlined evaporation pond. Four new ponds were dug to handle the overflow.

In 1951, however, there came reports of crop damage from farmers north of the arsenal who had irrigated their fields with pumped groundwater. By 1954, a drought year, the damage was severe, and by 1956 it was apparent that an area of several square miles had been affected. The liquid wastes, it became clear, had seeped out of the evaporation disposal ponds into the underlying aquifer and then flowed downslope toward the South Platte River.

Too Little Too Late

In response, the Army dug a new 100-acre reservoir and lined it with asphalt. It was a case of too little too late, the case study suggests, "because large amounts of contaminants were already present, in and slowly migrating through the aquifer." The lining eventually failed anyway.

The early seventies brought fresh claims of crop and livestock damage, and in 1975 the Colorado Health Department found a nerve gas byproduct—diisopropylmethylphosphonate (DIMP)—in a well eight miles away from the leaking disposal ponds and just one mile from the municipal water supply for the town of Brighton.

In response to the health department's "cease and desist" orders, the Army began cleaning up the mess. Using geohydrologic data plus engineering know-how, the Army developed an ambitious containment plan that

finally became fully operational last year. It included a 6,800-foot barrier of trenches 25 to 50 feet deep, 54 wells to pump contaminated water out of the aquifer, a 36,000-gallons-per-hour treatment plant, and 38 reinjection wells to put the cleaned water back into the aquifer outside the arsenal boundaries.

Safe Disposal Possible

To prevent future cases like Rocky Mountain Arsenal, the Research Council's report makes four recommendations:

1. Because the scientific understanding of the chemistry and transport of contaminants in groundwater is inadequate to predict their movement reliably, more research is needed. For example, it is important to learn how groundwater flows through fractured rock; how microorganisms such as bacteria might control chemical reactions; and how these, in turn, might affect the movement of contaminants.

2. Although information is incomplete, enough is already known to make a more thorough search for sites where the subterranean geologic properties are adequate for safe disposal of toxic wastes. These include huge basins that drain internally and therefore do not feed into streams or rivers that empty into the sea. Such basins are known to exist in parts of Nevada, Utah, and the surrounding areas, and it is believed that wastes placed there would remain isolated for many thousands of years.

3. The volume of toxic wastes now being generated would eventually overwhelm the ability to find new sites. To meet that likelihood, a strategy should be developed that would first segregate the wastes and then treat and dispose of each type separately. Separation is important because mixing wastes vastly complicates the problem of disposing of them safely.

4. And, finally, to deal with the "not-in-my-backyard" opposition to toxic waste disposal sites, state and national governments should work with industrial organizations to agree on disposal strategies for various classes of wastes.

"The public must understand," the report says, "that use of the products of technology carries with it the responsibility for safe disposal of that technology's wastes."

Better Models Tell A Less Drastic Story

Ozone and the Atmosphere

A NEW CHAPTER in the continuing saga of estimates of the effects of chlorofluorocarbons (CFCs) on atmospheric ozone has just been completed. As part of an ongoing program mandated by Congress, a Research Council committee has again reviewed current scientific understanding of whether increases in CFCs will cause decreases in the upper atmosphere ozone that protects the Earth from harmful ultraviolet radiation.

Use of CFCs as propellants in aerosols has been banned in the United States, but the compounds are being used here in increasing quantities as foam-blowing agents and continue to be used in refrigeration systems. And while their use has not been restricted abroad, teams of legal and technical experts working under the auspices of the United Nations Environment Programme are reportedly near agreement on a "global framework convention" covering information exchange, research, and monitoring of any substance that might modify atmospheric ozone. In a protocol to the convention, the United States recently proposed a mandatory worldwide ban on nonessential uses of CFCs that parallels current U.S. regulations.

The new Research Council study, funded by the Environmental Protection Agency, examined the most recent laboratory, field, and mathematical modeling studies describing the atmospheric chemistry of ozone, as well as additional literature on the possible impact of increasing ultraviolet light on human health, plants, and marine life.

The results: Two different kinds of models — one that considered only CFCs and another that took into account changes in a variety of trace gases —

Causes and Effects of Changes in Stratospheric Ozone: Update 1983. (1984, 272 pp.; ISBN 0-309-03443-4; available from National Academy Press, $15.50).

suggest less change in total stratospheric ozone than had previously been estimated.

Specifically, atmospheric models that consider CFC concentrations alone predict a 2 to 4 percent reduction in stratospheric ozone by late in the next century. Equivalent estimates made by previous Research Council committees in 1982 and 1977 had predicted a 5 to 9 percent reduction and a 15 to 18 percent reduction, respectively.

These latest measurements reveal less ozone at higher altitudes in the stratosphere and more ozone at lower altitudes.

Other models, which incorporate the effects of both CFCs and such trace gases as nitrous oxide, methane, and carbon dioxide, now predict that simultaneous changes in atmospheric concentrations of these gases could possibly cause an *increase* of about 1 percent in total stratospheric ozone over the next century. The committee noted, however, that the uncertainties in these models suggest that the result could range between an increase of a few percent to a decrease of as much as 10 percent.

Better Models = Better Results

Several factors account for these revised estimates. Most notably, the new calculations result from improved models that provide for simultaneous changes in several gases that affect ozone in the stratosphere. Also improved are the measurements fed into the models.

For example, the committee noted that improved measurements now show that the distribution of ozone in the stratosphere is different than earlier studies had indicated. These latest measurements reveal less ozone at higher altitudes in the stratosphere and more ozone at lower altitudes.

Better, too, are the field measurements of the concentrations of ozone and other gases, such as nitrogen oxides, methane, nitrous oxide, and carbon dioxide, at different atmospheric levels. These latter measurements, said the committee, indicate that the concentrations of both CFCs and these trace gases are increasing, a situation which may have substantial effects on atmospheric ozone in the future.

In particular, the committee noted that the so-called greenhouse effect, a warming of the Earth's surface caused by increases in atmospheric CO_2 and other gases, may produce a corresponding cooling of the stratosphere, where 95 percent of atmospheric ozone exists. Such a cooling would slow the rate of

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chemical reactions that destroy ozone. "Thus the question of perturbations to ozone should not be considered separately from the issue of climatic alterations due to other trace gases such as carbon dioxide."

According to the committee, detailed analyses of ozone concentrations from 1970 to 1980 have produced "no discernible trend" in the *total* amount of ozone in the atmosphere. Because an apparent decrease in ozone has been measured at an altitude of about 40 kilometers in the stratosphere, the committee reasoned that this decrease must have been offset by increases in ozone at lower altitudes.

In short, while the original premise that increases in CFCs alone would cause decreases in stratospheric ozone remains valid, the predicted effect of such increases has been greatly affected by more thorough understanding of the complexities of atmospheric processes.

Health and Other Effects

The second part of the committee's study examined the likely effects on humans, marine life, and plants of increases in ultraviolet radiation produced by a reduction in total ozone levels. To date, the committee noted, research has focused only on the effects of *increasing* ultraviolet radiation since earlier studies had concluded that ozone would, if anything, decrease, an assumption less certain in the face of the committee's latest findings.

Ozone concentrations in the atmosphere are particularly important in determining the amount of ultraviolet light with wavelengths between 290 and 320 nanometers (UV-B) that reach the Earth's surface. Wavelengths in this range are necessary for the production of vitamin D for human bone metabolism. Yet these same wavelengths may also cause permanent damage to DNA or other proteins.

Because the 1982 ozone report provided a comprehensive summary of the biological effects of UV-B exposure, the current report concentrated on new research in two rapidly advancing areas — malignant melanoma, an often-fatal skin cancer, and photoimmunology, the study of how light affects the immune system.

"The incidence and mortality rates of malignant melanoma have risen consistently in the United States during the past five decades," said the committee. "The rate of increase in mortality is now higher than that of any malignancy except cancer of the lung." The 1982 study found that even though incidence of the disease is greater in lower latitudes, the effects of

sunlight in producing the disease were not clear. Research cited by the current committee supports the connection between sunlight and malignant melanoma. However, whether UV-B or some other wavelengths of sunlight are responsible for melanoma remains unknown.

In 1982, laboratory research had recently demonstrated that exposure to UV-B radiation caused suppression of specific immune responses in animals. For example, UV-B-induced tumors that would normally have been rejected by healthy animals were shown to grow uninhibited following UV-B exposure. New data described in the current report has shown that UV-B radiation not only inhibits immune responses at the site of exposure, but also at "distant, unexposed sites." The committee concluded that this "systemic" effect of UV-B radiation demonstrates that changes in immune responses are a primary reason that UV-B exposure produces skin cancer in animals.

At least some of the immune-response changes noted in animals have also been observed in humans, said the committee. However, because the strength of immunologic changes due to UV-B exposure have not yet been measured, "implications for human health are not clear."

Effects on plants, crops, and other vegetation from increased exposure to UV-B are even less well understood. In plants, UV-B exposure has been shown to stunt growth, reduce total leaf area, reduce production of dry matter, and inhibit photosynthesis, but major uncertainties remain about why some plants are more susceptible than others. One possible explanation is that some plants in the tropics have evolved a resistance to UV-B exposure by producing compounds in their leaves that absorb UV before it reaches the chlorophyll.

All types of marine life from one-celled organisms to fish suffer effects of UV-B exposure, such as stunted growth and changes in reproduction, survival, and behavior. Once again, however, the committee pointed out that individual species differ "markedly" in their sensitivity to UV-B and "[t]he reasons for these differences remain unclear."

—GAIL PORTER and BARBARA JORGENSON

Looking for Potential Assassins

A NEW presidential campaign is under way, and with all the crowds, speeches, and hoopla comes the renewed threat of political assassination. The United States has endured a rash of shootings of presidents and would-be presidents during the past quarter century: the deaths of John and Robert Kennedy, the crippling of George Wallace, two attacks on President Gerald Ford, and the shooting of President Ronald Reagan.

During the coming months the U.S. Secret Service will be called upon to protect the President, the Vice President, their families, former presidents, Democratic presidential candidates, foreign heads of state visiting the Olympic Games in Los Angeles, and other designated persons.

An important part of the service's mission is to identify and take precautions against potential killers before they strike. It is an extraordinarily difficult task. Agents must investigate each of 4,000 potentially dangerous individuals who are referred to the service each year, evaluate behavior that is sometimes bizarre, and decide in a limited time whether a subject warrants further watching. A wrong judgment, such as the preliminary Secret Service evaluation in 1975 that Sara Jane Moore probably would not attack President Ford, can have dire consequences.

The service's 1,600 agents typically have little formal training in mental health disciplines. However, a new report by an Institute of Medicine (IOM) committee suggests that the service can employ perspectives from the fields of behavioral science and mental health to improve agent effectiveness in a number of practical ways.

The report follows a 1981 IOM conference for the Secret Service in which experts in psychology, criminology, medicine, and other fields discussed the potential usefulness to the service of their disciplines. The conference led the Secret Service, which is an agency within the Treasury Department, to establish an in-house research unit. The service also requested the IOM to form a study committee to make recommendations about how the service could improve research, training, and interaction with the mental health community.

The committee, chaired by W. Walter Menninger, director of the division of law and psychiatry at the Menninger

Research and Training for the Secret Service: Behavioral Science and Mental Health Perspectives. Institute of Medicine (1984, 77 pp.; available from the Institute; supply limited).

Foundation in Topeka, Kansas, dealt only with the specific question of evaluating and managing individuals who threaten the President or other protected persons. It did not address such other concerns as counteracting conspiratorial terrorism or changing the behavior of the President to limit risks.

Mental Illness a Concern

Of the 12 individuals in American history who have attacked a president, all but the two Puerto Rican terrorists who tried to kill President Harry Truman in 1950 later were deemed to be mentally disturbed. The most recent known presidential assailant, John Hinckley, was found by a jury to be not guilty by reason of insanity. In fact, of the approximately 350 people that the Secret Service deems dangerous at any given time, *95 percent* have histories of contact with the mental health sector.

Predicting the likelihood that such persons will attack the President is an imperfect science at best. Psychiatrists and psychologists have tried to develop behavioral models of assassins, but the rarity of the event makes it impossible to validate these models directly. Secret Service agents therefore must base assessments of dangerousness on subjective judgments and experience.

The report calls for research to help the Secret Service blend its extensive practical experience with a more systematic understanding of human behavior, and for training to assist agents in making clinical assessments of possible dangerousness.

"The extremely grave consequences of assassination of governmental leaders require that the Secret Service identify as precisely as it can the characteristics of those individuals who are most likely to attempt assassination," the report notes.

It is difficult — if not impossible — to create an objective profile of likely assassins because the number of past assassins provides such a small research base from which to extrapolate a behavioral model. However, the report suggests ways in which the Secret Service research unit might be able to expand the research population, for example, by including persons apprehended before actually attacking a president or assassins of other public officials and celebrities.

Studies could provide better understanding of the degree to which such factors as interest in harming a protected person, possession of weapons, ability to plan an attack, drug and alcohol abuse, mobility, or sudden loss of a family member or job indicate dangerousness.

Identifying "assassin attributes" is just half of the problem. The other is to understand better how agents presently assess suspects, and to train them to integrate empirical facts about dangerousness with their own experience and feelings. Like master medical diagnosticians, experienced agents also must learn to verbalize their decision-making process for study and analysis by others.

Practical Training

At the same time research is being conducted, the report recommends, agents need to receive more training about mental health concepts and skills relating to potentially violent people.

They should be exposed to experienced clinicians, learn about clinical interview techniques, and become aware of the legal and ethical constraints on mental health professionals. They also need to learn about the episodic aspects of certain mental disorders and how these are affected by different medications, alcohol abuse, life stresses, and other factors.

As far as possible during training, agents should interview and assess dangerous persons under the guidance of experienced colleagues and mental health clinicians. At the same time, however, the report warns trainers not to try to turn special agents into mental health practitioners.

"Therapeutic and criminal justice goals and roles should be recognized as distinct from each other and no attempt should be made to divert special agents from their prime duty in law enforcement and guarding the safety of protected persons," the report states. "Secret Service agents themselves are the most experienced persons in judging the dangerousness of potential assassins to their protected persons and they can look to mental health and behavioral scientists only to supplement, not supplant, their own judgments, skills, and resulting decisions."

Improved contact with mental health professionals and behavioral science experts should not be limited to training, the report recommends. It notes that while the overwhelming majority of persons deemed dangerous by the Secret Service have had contact with mental health professionals, the Secret Service itself lacks a continuing relationship with the mental health community. While contacts between agents and mental health experts will be constrained necessarily by ethics, confidentiality, and other factors, the report suggests that Secret Service field offices might establish productive working relationships with local mental health resources.

—DAVID JARMUL

Engineering Academy Aids NSF With Proposed Research Centers

IN ITS FY 1985 BUDGET unveiled in Washington last month, the National Science Foundation (NSF) proposed the establishment of a group of cross-disciplinary research centers on university campuses around the country to strengthen both engineering research and education and to improve academic ties with America's industrial community.

At a briefing on the proposed budget, Presidential Science Advisor George A. Keyworth singled out these so-called Engineering Research Centers as one of five priority areas, noting that they were to be established "with the aid of the National Academy of Engineering."

The Academy's aid came in the form of a study, requested by the NSF in late December and completed in mid-February. The NSF wanted advice on how to structure the centers, how to select them, how much to fund them, how many to have and for how long, and how the new centers should interact with industry.

Guidelines for Engineering Research Centers. National Academy of Engineering (1984, 25 pp.; available from the Academy).

The panel's report recommended that 25 centers be the goal, with perhaps 5 to 10 centers being established in the first year. Twenty-five, the panel explained, was "our best judgment as to the number of schools which can provide the disciplinary breadth and can absorb the level of funding we envisage without distorting their over-all research programs." But an engineering school unable to sponsor its own center could still participate as an "academic affiliate." By sharing faculty, cooperating in research, and working with the center in a number of ways, affiliates can make it possible for a center to exert a substantial regional impact, the report pointed out.

Further, as panel chairman W. Dale Compton of Ford Motor Co. wrote in the report's preface, ". . . it is better to have fewer centers with sufficient funding rather than many with inadequate funding."

Core NSF funding, the panel estimated, would run from $2.5 to $5 million annually per center or about $100 million per year, not including stipends and tuition, at the end of a five-year development period. This amount, it ex-

plained, was calculated to allow each of 25 centers to affect directly at least 10 percent of the master and doctoral engineering students in the center's home institution. A minimum faculty commitment of three full-time equivalent positions per center is also needed, said the panel.

No single model was recommended. The panel envisioned a range of models, each sharing a primary emphasis on engineering research and mirroring "unique combinations of local interests and capabilities." Both team research and research participation by affiliates should be encouraged.

Flexibility in project selection is essential, stressed the panel. Each center should be allowed to choose its own programs, with more independence "than is typical of individual grants programs."

Furthermore, the panel said, "those administering the program must allow the centers considerable latitude in how they plan to attain their goals. . . . Any [center] should be sufficiently protean to respond to new ideas, techniques, and relationships, inside and outside the university."

Industry Involvement

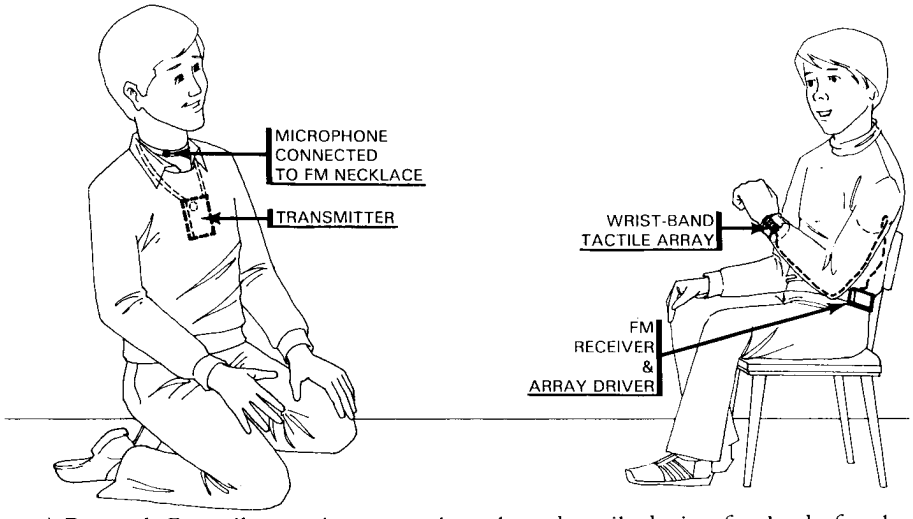
Industry's involvement in both the overall program and the individual centers must be "substantial and continuous," the panel declared. Each center should be associated with one or more industrial or other organization involved in engineering practice, and the NSF oversight panels should include industrial representatives.

Robert M. White, president of the National Academy of Engineering, testified in support of the centers program at the NSF authorization hearing of the Senate Subcommittee on Science, Technology, and Space. The panel's report is slated to be discussed at an April meeting planned by NSF.

—B.J.

Touch as a Substitute for Hearing

FOR THE PROFOUNDLY DEAF, a conventional hearing aid is not much use. The sense of touch has long been viewed as a possible substitute for hearing, but although several devices have been designed, none has been suitable. A vibrator attached to the wrist or other part of the body can present sound waves transformed into impulses that can be felt on the skin. Such a tactile aid can complement but cannot replace lipreading.



A Research Council committee recently evaluated tactile devices for the deaf at the request of the National Institute of Neurological and Communicative Disorders and Stroke. It recommended "early and widespread deployment" of tactile aids to assess their effectiveness in everyday use. Young children in particular may benefit, suggested the committee, noting that "it would be expected that early and continual use of such a device would provide the best chance for later acquisition of skilled acoustic-tactile processing." The system illustrated above is one of several under development; this one is designed for classroom use by five- and six-year-olds.

Basic and Applied Research on Tactile Aids for Deaf People: Progress and Prospects (Working Group 90, Committee on Hearing, Bioacoustics, and Biomechanics; report will appear in a forthcoming issue of the *Journal of the Acoustical Society of America*).

Seminar Reviews Ways to Keep U.S. Technology in Friendly Hands

IT IS NO SECRET that agents for the Soviet Union will buy, borrow, or steal to obtain American technology. Much of the technology that passes into Soviet hands and ultimately into its weapons systems is obtained on the open market through diversionary tactics involving third and fourth countries. American-made computers, believed headed to the U.S.S.R., recently were confiscated in Sweden.

The Central Intelligence Agency (CIA) estimates that some 100,000 people are involved in the U.S.S.R's scouring of the West for information and technical know-how and that this incessant search is directed from the highest levels of Soviet government.

Most Americans do not quarrel with the conclusion that American technology gives the U.S.S.R. the means to upgrade its arsenal in a shorter time than if it had to rely on its own research and development. Nor do they quarrel with the thesis that the Soviet Union's extensive use of American technology is forcing the U.S. and Western Europe to spend billions of dollars to keep pace. However, considerable controversy revolves around ways to control the export of goods and know-how that the Russians can put to military use. This was the essence of a recent seminar on export controls organized by the Academies of Sciences and Engineering for participants in the Academy Industry Program.

The program was particularly timely because the Export Administration Act, which grants the president authority to stop shipments of sensitive technology, expired the end of February, and reauthorization proposals were being considered by Congress. The debate centered on how to monitor high-technology exports to Western Europe and what role the Department of Defense should play in the licensing process.

Sensitive goods pass along complex trade channels from West to East. John N. McMahon, deputy director of the CIA, described a typical route from the U.S. to South Africa to West Germany to Sweden and eventually to the U.S.S.R. There are at least five networks of some 300 firms operating in Europe and involving about 30 countries, he told

seminar attendees. "The U.S. alone cannot respond adequately to the threat, but it must take the lead," he said.

William Schneider, Jr., undersecretary for security assistance, science, and technology for the Department of State, seconded this contention. "Unilateral controls generally are not effective," he declared. "It is essential that we have a multilateral approach." The vehicle for obtaining allied cooperation in dealing with high tech trade is the Coordinating Committee for multinational export controls (COCOM), a body consisting of most NATO members and Japan. Schneider contended that following Europe's displeasure with U.S. policy regarding the Soviet pipeline, there has been "a fundamental change in their attitudes." Export control activities must be equitable and consistent to gain support, he pointed out.

Speaking from the exporters' perspective, Roland W. Schmitt, senior vice president for corporate research and development at General Electric Co., said he feared that an "obsession with defensive strategy will cripple offensive strategies for developing new technologies." Some government proposals, he noted, could hamper the administration's objectives to assure that U.S. technology for defense is superior.

Schmitt urged the administration to keep some guidelines in mind when developing control policies: dual use — many technologies may be used commercially as well as militarily, and controls should be applied "downstream" at the application level, not "upstream," where they "could affect our ability to develop more [technology]"; military criticality — avoid confusing technology that is critical to military needs with that which is merely useful; foreign availability — consider whether the U.S.S.R. can obtain equivalent technology from other sources; technology transfer — control of manufacturing know-how may be more important than curtailing export of products.

Other speakers from federal agencies, industry, and academe explored details of policy and procedure in formal presentations and in discussions with attendees. Frequent proposals echoed the findings of a panel of the Committee on Science, Engineering, and Public Policy (COSEPUP) in the 1982 report, *Scientific Communication and National Security*. That panel cautioned that overly restrictive controls on exchange of scientific information can weaken, rather than strengthen, U.S. defenses by discouraging technological innovation. It recommended criteria for judging whether restrictions are warranted.

Mitchel B. Wallerstein and Lawrence C. McCray, who served on the staff for that report, recently reviewed government export control actions since its publication and concluded that little has been done that reflects the panel's proposals.

The Academy Industry Program consists of 57 companies which have made unrestricted contributions to support projects initiated by the academies. Several times a year representatives of those companies are invited to Washington to attend seminars on timely topics.

—P.L.

Academy Distributes Booklet on Science and Creationism

DIFFERENCES between science and creationism are the subject of a new booklet by a special committee of the National Academy of Sciences.

Commissioned by the Academy's governing Council to state the view of scientists on claims that creationism should be taught in high school science classes, the brochure was authored by a committee of scientists assisted by legal scholars. James D. Ebert, president of the Carnegie Institution and vice president of the Academy, chaired the authoring committee.

The 28-page booklet defines science and the scientific method and concludes that, when tested by that method, creationists' beliefs have been found wanting. Therefore, the booklet argues, it is not appropriate to teach creationism alongside established scientific theories in a science classroom.

Wrote Academy President Frank Press in his preface to the booklet: "Both views have a place in our lives — but one belongs in the world as we have come to know it and one belongs in history. . . .

"Teaching creationism is like asking our children to believe on faith, without recourse to time-tested evidence, that the dimensions of the world are the same as those depicted in maps drawn in the days before Columbus set sail with his three small ships, when we *know* from factual observations that they are really quite different."

In an initial mailing, some 44,000 copies of the booklet are being distributed free by the Academy. Additional copies are available for purchase. Among those to receive complimentary copies are all school district superintendents, heads of all secondary school science departments, members of the National Science Teachers Association and other professional organizations, and selected members of Congress.

Preparation of the brochure was supported by the Academy, the Mary Reynolds Babcock Foundation, and others.

Science and Creationism: A View from the National Academy of Sciences. Committee on Science and Creationism (1984, 28 pp.; available from National Academy Press, $4.00).

Teaching Doctors About Nutrition

THE PROLIFERATION in recent years of salad bars and diet foods shows that many Americans are concerned about the health effects of the foods they eat.

Unfortunately, some doctors are not as prepared as they might be to answer patient questions about diet. Fewer than one-third of American medical schools require their students to take training in nutrition.

For this reason, the Research Council's Food and Nutrition Board has formed a committee to examine how the study of nutrition in medical education can be strengthened.

The committee will examine nutrition education at different medical schools and make recommendations about curricula, teaching methods, and related issues. Its work will be coordinated with a more general effort by the Institute of Medicine to examine fields of growing importance in medical education, particularly preventive medicine.

Myron Winick, director of the Institute of Human Nutrition at Columbia University, chairs the new committee. Support for the 18-month study is being provided by the Ruth Mott Fund, the William H. Donner Foundation, and the Research Council through a consortium of foundations, the Academy Industry Program, and the National Academy of Sciences endowment.

Research for Quality in Mathematics and Science Education

A GOOD DEAL of rhetoric has been expended recently on the poor state of mathematics and science education in American public schools. Numerous suggestions for improving curricula and instruction have been offered, but few have been evaluated scientifically.

A Research Council committee, chaired by James G. March of the Graduate School of Business at Stanford University, will advise the National Institute of Education on research to illuminate particular problems in education and to aid in effecting improvements.

The committee is likely to focus on such areas as the recommendations from the National Commission on Excellence in Education, the National Science Board Commission on Mathematics,

Science and Technology Education, and others for improving school performance; new insights into the learning process that might be borrowed from the fields of cognitive science and artificial intelligence for use in the classroom; rapidly developing computer and communications technologies that may be adapted to education needs; and factors that influence the recruitment and retention of high quality teachers.

Non-cognitive factors such as motivation, emotional development, family and school environments, and peer pressures also contribute to learning. A workshop, funded by the William T. Grant Foundation and organized under the auspices of the same committee, will explore the role of these influences on learning.

The initial phase of the study is scheduled for completion at the end of the year.

Is There a Shortage of Transportation Professionals?

DURING the years the Interstate Highway System was being constructed, federal and state governments expanded staffs of transportation professionals. As the roads were completed and highway construction received less emphasis, hiring slackened or stopped in some states, and the number of professionals remained static.

Now large numbers of the professionals hired to oversee Interstate highway construction are nearing retirement age. Similar conditions prevail in many transit agencies, hard hit by declining budgets. Concerned that mass retirements may leave several states without sufficient expertise to staff highway and transit agencies, the Congress directed the Secretary of Transportation to contract with the Research Council's Transportation Research Board for a 15-month study.

The committee, headed by Lester A. Hoel, chairman of the civil engineering department at the University of Virginia, will project future supply and demand for transportation professionals; assess how shifts in program emphasis, technological advances, and institutional changes will alter future needs; and evaluate policies for recruiting, training, and retaining staff.

This study is one of four mandated by the Surface Transportation Assistance Act of 1982 (P.L. 97-424). The other studies are: costs and benefits of the 55-mile speed limit, design standards for repair of non-Interstate highways, and the effects on highways and safety of twin-trailer trucks.

Brief Takes . . .

From an address by Secretary of Transportation Elizabeth Hanford Dole at the 63rd annual meeting of the Transportation Research Board in Washington on January 18.

. . . [O]ver the last 12 months I have focused on other priorities demanding our attention. Perhaps most important are the ways we address or fail to address how transportation affects our environment.

Some things already have been achieved. Certain environment safeguards are in place. No federally assisted transportation project, for example—be it a new highway or a new bike trail—can proceed without a detailed environmental assessment. By the end of this year, the oldest and noisiest jets will have been weeded out of the U.S. airline fleet, and aircraft engine manufacturers are now required, as of the first of this month, to reduce exhaust emissions by 60 to 70 percent. We have developed strict oil pollution and hazardous cargo guidelines as a further effort to protect the environment and protect the quality of American life.

All of that is well and good. But I am not satisfied that we have probed the limits of our responsibility — or plumbed the depths of possibility. We should not tolerate excessive noise; we must find reasonable ways to reduce it. We should not excuse pollution; we must develop ways to prevent it. And we must not sacrifice history for progress; there is almost always a way to preserve our historic landmarks.

We have explored but the coastal plain of a vast continent of environmental concern. To speed up the process, I have formed a steering group within the department, headed by a counselor on environmental concerns, to examine the prospects for further environmental actions, including the areas of reducing airport noise and oil pollution, improving the highway environment, handling the transport of hazardous materials, and safeguarding historic sites. . . .

According to the Census Bureau, residents ranked noise second only to crime as a reason for moving from urban neighborhoods. Emissions from cars and trucks and buses still account for a substantial share of city pollution. We need innovative planning and design to reduce transportation intrusions on urban communities.

Items . . .

New Publications

For documents shown as available from the National Academy Press (NAP) or from a specific unit of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, National Research Council, committees or boards, write to the listed source at 2101 Constitution Avenue N.W., Washington, D.C. 20418. Other documents are available from other sources as noted. For current NTIS prices and NTIS documents, write to the National Technical Information Service, Springfield, Va. 22161. Prices and availability of all documents are subject to change.

Firewood Crops: Shrub and Tree Species for Energy Production, Volume 2

Advisory Committee on Technology Innovation, Board on Science and Technology for International Development (1983, 99 pp.; single copies available to institutions from the board; supply limited).

Multiple Hazard Mitigation: Report of a Workshop on Mitigation Strategies for Communities Prone to Multiple Natural Hazards

Advisory Board on the Built Environment (1983, 71 pp.; available from NTIS; PB 84-154889).

New Frontiers in Mammalian Reproduction and Development: Proceedings of the Symposium, March 7-11, 1983

Committee on Animal Models and Genetic Stocks, Institute of Laboratory Animal Resources (in Nov. 1983 issue of *Journal of Experimental Zoology*, Vol. 228, No. 2, pp. 165-395; single copies available from the Institute; supply limited).

Meetings Special Announcements

This schedule lists public meetings and includes other special announcements of units of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council. The schedule is prepared early, and details are subject to change and should be checked directly with project offices as noted below. Any written submissions should be sent directly to the listed unit at 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Third International Conference on Concrete Pavement Design and Rehabilitation, Apr. 23-25, 1985, West Lafayette, IN, Purdue University. Cosponsored by the Transportation Research Board. Synopses are due by May 11, 1984, and should be sent to: Cochairmen E. Hancher and C. Scholer, Conference on Concrete Pavement Design and Rehabilitation, Civil Engineering Building, Purdue University, West Lafayette, IN 47907. For additional information: E. Hancher, 327/494-2159.

Associateship Programs. Office of Scientific and Engineering Personnel, National Research Council (NRC), is accepting applications for the June 1984 review for NRC Research Associateships in the National Aeronautics and Space Administration, Air Force Systems Command, Environmental Protection Agency, Naval Air Development Center, Walter Reed Army Institute of Research, Army Missile Command, and Army Armament, Munitions, and Chemical Command. Opportunities for basic research in the natural sciences and engineering are available to recent recipients of doctorates, to senior investigators, and in most instances to non-U.S. citizens. For applications and program details, write to: Associateship Programs, JH 608-D, at the above address. Applications must be postmarked by April 15, 1984. For further information: A. Crump, 202/334-2760.

News Report

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