CONOCO

Interoffice Communication

To H. R. Flammer

From E. L. Kieschnick

Date October 4, 1982

Subject VINYL INSTITUTE: INTERIM ORGANIZATION

The concept of the Vinyl Institute as an organization of the SPI has been proposed to the SPI. The proposed organization is designed to encompass and resolve issues specific to the vinyl industry. It is anticipated that the Vinyl Institute will be organized and its programs implemented during the next 6-12 months.

Unfortunately, current and anticipated events in the areas of major codes, legislative bills, and civil suits may severely limit PVC's use in the construction industry. As a result, strategies must be established and plans implemented within the next 3-6 months. As such, it is proposed that an interim organization be formed to encompass and resolve the issues as outlined herein. The proposal assumes that the interim organization will be directed by an individual familiar with the issues [redacted] who has a background in higher levels of commercial management.

Discussion

The usage of PVC in the construction industry has grown to the point that it has significantly impacted on competing materials. Those affected, particularly the steel pipe and conduit industry, have elected to fight the issue in the public domain encompassing alleged issues of toxicity and flammability/combustability. Additionally, labor unions and environmentalists have supported efforts to reduce or restrict PVC's usage. These efforts have been strengthened within the last two to three years based on alleged links between fire deaths and Hcl emissions during fires.

The three major areas in which these issues have been raised are in construction codes, legislative bills, and civil suits. Efforts to clarify and absolve PVC have been undertaken by various groups in the industry, but with mixed results. The major problem revolving around clearly defined answers and a coordinated response to the specific issues.

In 1982, various industry spokesmen were responsible for identifying these concerns and in proposing the formation of a Vinyl Institute within the organizational structure of the SPI. Conoco has supported this effort and agrees with both the intent and direction that the Institute has outlined.

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Unfortunately, several major areas of concern, as outlined in Table I, have risen which require immediate attention.

The timing for these issues is listed in Table II. As shown, major or far reaching decisions will be reached within 3-6 months in each of the three areas previously mentioned. As a result, an interim group or organization is required to insure that the facts are clearly defined and presented in each situation.

The short term action required of such an organization are detailed in Table III. In summary, the organization should:

1. Prepare for and coordinate activities for known areas of contrast with the May, 1983 NFPA meeting being the top priority.

2. Establish response capabilities or functions for future issues or areas of contrast.

3. Initiate or coordinate industry code and legislative efforts.

4. Develop documented position on major issues.

5. Expand and coordinate research efforts to convincingly arrest allegations against PVC.

Recommendations

It is recommended that the organization responsible for these activities be introduced as an interim form of the Vinyl Institute until such time as the Institute can adequately develop laws and by-laws, organizational and adminitrative structures, and overall vinyl industry strategies.

The organizational form recommended is as depicted in Table IV and is similar in concept to that proposed for the Vinyl Institute. The major differences lie in the interim organization having six main personnel from which the organization's strategies/objectives will be implemented. This minimum number of people will provide both close communication and targeted approaches to key situations/issues. The personnel involved can obviously draw from existing industry groups or consultants to administer programs.

A listing of the recommended group assignments are provided in Table V. Two areas of departure are in the emergency and research groups. The emergency group has been expanded to a CCCS team responsible for all plastics. Once on sight, the CCCS team can handle initial situations and/or notify affected industry groups. In the research area, it is strongly recommended that current research be re-emphasized to answer the transport phenomena surrounded Hcl and the irritant nature and severity of Hcl on primates.

It is important to note that the key to the validity, credibility, and expediency with which the group must act dictates that the Interim Director must be both familiar with the issues and capable of managing a diverse group of activities within a narrowly defined time frame. As a result, a fairly high level manager with a business or commercial background in the PVC industry is recommended.

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Implementation

The above plan is offered for introduction at the October 6, 1982 Vinyl Institute Steering Committee meeting for consideration and modification. It is suggested that the Interim Director and five (5) key group leaders be selected in that meeting such that the organization can be named and introduced prior to the end of October.

Ed Kieschnick

E. L. Kieschnick

smb

cc: HJH JJL PHW

News

The Vinyl Institute

Contact: J. M. Joyce
Phone: 216/447-7921

PVC/VCM INDUSTRIES ORGANIZE THE VINYL INSTITUTE

CHICAGO, November 11--Major producers voiced a commitment to the continued growth of the polyvinyl chloride (PVC) and vinyl chloride monomer (VCM) industries as they met to establish the Vinyl Institute.

The Vinyl Institute, organized to address the specific needs of the PVC/VCM industries, will promote the use of vinyl resins and compounds for a wide range of socially valuable end products. PVC is the world's second largest-selling plastic and has hundreds of construction, furnishing, transportation, medical and consumer product applications.

In addition, the Institute will serve as the focal point for responding to "unfounded attacks" from competitive interests, launched as customers have turned increasingly to PVC from the use of steel and other construction materials. The new organization will be an operating division of the Society of the Plastics Industry and is comprised of domestic PVC and VCM producers, with associate memberships available to foreign producers.

The Vinyl Institute was organized to augment the governmental relations, public relations and educational efforts of individual companies and will call upon the resources of both member companies and SPI to accomplish its communications programs.

"The formation of a cohesive organization to serve the PVC/VCM industries is long overdue," said Bart A. DiLiddo, president of the BFGoodrich

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The Vinyl Institute • Box 31357 • Cleveland, • Ohio • 44131

Chemical Group, who was elected the first chairman of the Vinyl Institute. "Our combined efforts to support the marketplace acceptance of PVC will result in strong, efficient and cost-effective programs."

DiLiddo added that the Institute's executive board will be hiring a paid, permanent staff and leasing headquarters space within the next few months. Other industry executives elected to the board are Guy E. Disch of Tenneco Chemicals, Inc. (elected vice chairman), H. Richard Flammer of Conoco Inc. (secretary), Lawrence A. Wheeler of Shell Chemical Co. (treasurer), Russell F. Gervais of Occidental Chemical Corp., Fred Timpe of CertainTeed Corp. and J. Frank Whitley of Dow Chemical U.S.A.

Other charter companies include Borden, Inc., The Goodyear Tire & Rubber Co. and PPG Industries, Inc. DiLiddo says he expects another four to six producers to join within the next several months.

Pending establishment of a full-time Institute staff, those wanting further information can call BFG's toll-free "PVC Interchange," 800-321-2916.

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THE VINYL INSTITUTE

AN ACTION PLAN

JULY 29, 1982

THE VCM/PVC INDUSTRY IS FACED WITH A BROAD LIST OF ALLEGATIONS IN THE CONDUCT OF ITS BUSINESS AND THE USE OF ITS END PRODUCTS.

SLIDE #1

AS YOU MAY KNOW, THOSE ALLEGATIONS INCLUDE THE FOLLOWING ISSUES: THE EXPOSURE OF EMPLOYEES AND THE PUBLIC TO VCM IN ITS MANUFACTURE AND TRANSPORTATION, AND IN THE MANUFACTURE OF PVC; RESIDUAL VCM IN THE PRODUCT; AND THE DISPOSAL OF BY-PRODUCTS. IN END USE APPLICATIONS, THERE ARE ISSUES ON THE COMBUSTIBILITY OF PVC; ON THE EXTRACTION OF COMPOUNDS FROM PVC; THE TOXICITY OF PLASTICIZERS AND STABILIZERS; AS WELL AS OTHERS.

SLIDE #2

TODAY THESE ALLEGATIONS ARE BEING ADDRESSED BY A MYRIAD OF ORGANIZATIONS--MANY WITHIN SPI, SOME OUTSIDE OF SPI. THE PVC/VCM INDUSTRY IS SPENDING MILLIONS OF DOLLARS EACH YEAR IN SUPPORT OF THESE ORGANIZATIONS AND IN CONNECTION WITH THESE ALLEGATIONS. THE COMPLEXITY OF ISSUES AND THE NUMBER OF ORGANIZATIONS INVOLVED HAVE FREQUENTLY RESULTED IN AN UNCOORDINATED, INEFFICIENT EFFORT, AND OF COURSE, THE WASTE OF MANY DOLLARS. WE IN THE INDUSTRY NEED TO BRING ORDER TO THIS CHAOS. WE PROPOSE TO DO THIS BY ESTABLISHING A VINYL INSTITUTE TO BETTER ORGANIZE, MONITOR, AND CONTROL THE INDUSTRY'S ACTIVITIES IN RESPONDING TO THESE ALLEGATIONS.

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SLIDE #3

TO BE EFFECTIVE FOR THE INDUSTRY, THERE ARE CERTAIN REQUISITES THAT THE INSTITUTE MUST MEET. IT MUST BE RESPONSIVE TO ISSUES, QUICK AND DECISIVE IN ITS ACTIONS, AND KNOWLEDGEABLE ABOUT THE INDUSTRY AND ITS PRODUCTS. THE INSTITUTE MUST BE AN ORGANIZATION WITH A SINGLE PURPOSE--THAT IS, AN ORGANIZATION DEDICATED TO THE VINYL INDUSTRY'S INTERESTS, THE BEST INTERESTS OF THE PUBLIC, AND ABLE TO ACT ON THOSE INTERESTS. IT MUST HAVE A DEDICATED STAFF, A STAFF WHOSE ONLY RESPONSIBILITIES ARE VINYL, AND FINALLY, MEMBERSHIP IN THE INSTITUTE MUST BE OPEN TO ALL INTERESTED PARTIES, IRRESPECTIVE OF OTHER AFFILIATIONS.

SLIDE #4

THE MISSION OF THE INSTITUTE WILL BE TO PROMOTE CONTINUING GROWTH FOR THE PVC/VCM INDUSTRY IN THE U.S., AND TO SERVE THE BEST INTERESTS OF THE PUBLIC BY PROVIDING SOCIALLY VALUABLE PRODUCTS. THE INSTITUTE'S OBJECTIVES WILL BE TO (1) IDENTIFY ALL ISSUES OF POTENTIAL CONCERN TO THE PVC/VCM INDUSTRY, (2) PRIORITIZE AND EFFECTIVELY DEAL WITH THESE ISSUES, (3) INTERACT WITH OTHER TRADE ASSOCIATIONS TO EFFICIENTLY USE INDUSTRY RESOURCES AND (4) BECOME THE SPEAKING ORGANIZATION FOR THE PVC/VCM INDUSTRY TO ASSURE PUBLIC UNDERSTANDING OF THE MERITS OF INDUSTRY PRODUCTS.

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SLIDE #5

TO MEET THESE OBJECTIVES, THE INSTITUTE MUST HAVE ITS OWN PERMANENT STAFF, INCLUDING AN EXECUTIVE DIRECTOR, A SECRETARY, AND UP TO TWO FULL TIME MANAGERS. IT WILL SERVE AS THE INDUSTRY FOCAL POINT FOR THE COORDINATION OF THE INDUSTRY'S EFFORTS IN ADDRESSING ISSUES AS THEY DEVELOP. ITS RESOURCES WILL INCLUDE PURCHASED SERVICES FROM AN UMBRELLA ORGANIZATION, OUTSIDE ORGANIZATIONS, PLUS THE COMMITTEES SHOWN HERE. THE COMMITTEES WILL BE HEADED AND STAFFED BY INDUSTRY PEOPLE. THEY WILL BRING TO THE INSTITUTE THE EXPERTISE REQUIRED IN ADDRESSING SPECIFIC ISSUES.

THE EXECUTIVE DIRECTOR WILL BE RESPONSIBLE FOR THE OVERALL OPERATION OF THE ORGANIZATION, THE IDENTIFICATION OF ISSUES, FOR ESTABLISHING PRIORITIES BASED ON THE MEMBERS' INPUT, FOR DETERMINING WHAT SERVICES AND RESOURCES ARE NEEDED BY THE INSTITUTE, AND FOR ARRANGING THEIR SUPPLY AND DEPLOYMENT. HE WOULD REPORT TO THE BOARD OF DIRECTORS. WE HOPE THAT THE INSTITUTE CAN FIT UNDER THE UMBRELLA OF THE SPI. IN THAT CASE, THE EXECUTIVE DIRECTOR OF THE VINYL INSTITUTE WOULD COORDINATE WITH THE PRESIDENT OF THE SOCIETY TO ASSURE THAT THE GOALS AND OBJECTIVES OF <u>BOTH</u> THE INSTITUTE AND THE SOCIETY ARE MET. OF COURSE, THE RELATIONSHIP WITH

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THE SPI WOULD BE STRUCTURED TO ALLOW THE INSTITUTE TO MEET THE REQUISITES EARLIER DESCRIBED.

SLIDE #6

INITALLY, ACTIONS OF THE INSTITUTE WILL BE LARGELY DEFENSIVE. WHILE ITS ACTIVITIES WILL BECOME MORE POSITIVE, NEAR TERM, ESTABLISHMENT OF A QUICK RESPONSE CAPABILITY IS NEEDED, TOGETHER WITH MORE ACTIVITY IN LEGISLATIVE AND CODE AREAS. LONGER TERM, THE INSTITUTE NEEDS TO GET THE "PLUSES" OF THE INDUSTRY'S PRODUCTS TO THE PUBLIC. THE INSTITUTE AS DESCRIBED PROVIDES THE VEHICLE FOR DOING THIS.

THE OPPONENTS OF PVC ARE PRESENTLY BETTER ORGANIZED THAN THE INDUSTRY. THEY HAVE BEEN SUCCESSFUL AS A DISRUPTIVE FORCE. WITHOUT A COORDINATED INDUSTRY RESPONSE, THESE ADVERSARIES WILL RESTRICT AND UNDERMINE INDUSTRY MARKETS, ELIMINATE GROWTH POTENTIAL, AND CONTINUE TO MISINFORM THE PUBLIC. THE INDUSTRY MUST GET ITS STORY TOLD. IT IS A GOOD STORY, ONE THAT IS SUPPORTABLE TECHNICALLY AND ECONOMICALLY, AND ONE THAT IS IN THE BEST INTERESTS OF THE PUBLIC.

SLIDE #7

WE HAVE TALKED ABOUT THE ISSUES, THE MANY ORGANIZATIONS CURRENTLY ESTABLISHED TO ADDRESS THEM, THE NEED TO EDUCATE THE PUBLIC ON THE ISSUES,

AND THE NEED FOR A NEW ORGANIZATION TO PULL IT ALL TOGETHER. NOW WE WANT TO TALK ABOUT THE FUNCTION OF THE UMBRELLA ORGANIZATION, WHICH WE WOULD LIKE TO BE THE SPI.

WE BELIEVE THE INSTITUTE AND THE SPI HAVE MUCH TO OFFER EACH OTHER. WHILE THE INSTITUTE WILL HAVE ITS OWN STAFF, IT WILL NEED MANY ADDITIONAL SERVICES WHICH THE SPI CAN PROVIDE. THESE INCLUDE, FOR EXAMPLE, OFFICE AND ADMINISTRATIVE, LEGAL, INFORMATIONAL DATA BANK ACCESS, A DISASTER INVESTIGATION TEAM, AND MANY OTHERS. FOR ITS PART, THE INSTITUTE CAN HELP FUND THESE SPI ACTIVITIES, WHICH FOR THE MOST PART ARE IN PLACE ALREADY, AND REDUCE THE FINANCIAL BURDEN FOR ALL SPI MEMBERS. FURTHERMORE, THE CLOSE ASSOCIATION OF THE SPI AND THE INSTITUTE WILL HELP ASSURE A UNITED FRONT AGAINST COMMON THREATS, AS WELL AS ADDITIONAL RESOURCES TO MEET THEM.

THE INSTITUTE HAS NO WISH TO DIMINISH MEMBERSHIP IN THE SPI. TO THE CONTRARY, WHILE INSTITUTE MEMBERSHIP WILL BE OPEN TO ALL, IT WILL ENCOURAGE ITS MEMBERS TO ALSO BELONG TO THE SPI. IN ADDITION, THE INSTITUTE BYLAWS WILL BE STRUCTURED TO REINFORCE THIS ENCOURAGEMENT. WHILE NOW SPI MEMBERS OF THE INSTITUTE WILL HAVE THE RIGHT TO PARTICIPATE FULLY IN ALL ACTIVITIES OF

THE INSTITUTE, INCLUDING THOSE OF ITS BOARD AND COMMITTEES, THE RIGHT TO VOTE ON ISSUES COMING BEFORE THE GENERAL MEMBERSHIPS WILL, EXCEPT FOR MATTERS WHICH HAVE FINANCIAL IMPACT ON NON SPI MEMBERS OF THE INSTITUTE, BE RESTRICTED TO THOSE MEMBERS OF THE INSTITUTE WHO ARE ALSO SPI MEMBERS. WE UNDERSTAND THAT THE SPI ITSELF IS ATTEMPTING TO TAILOR THE SERVICES IT PERFORMS FOR ITS MEMBERS TO ASSURE THE BROADEST POSSIBLE INTEREST IN THEM. THIS WILL ALSO ENCOURAGE INSTITUTE MEMBERS TO BE SPI MEMBERS SINCE INSTITUTE NEEDS AND FUNDING SHOULD CLOSELY PARALLEL SPI NEEDS AND FUNDING IN THE FUTURE.

WHILE THE STAFF OF THE INSTITUTE WILL REPORT TO THE INSTITUTE BOARD THROUGH ITS EXECUTIVE DIRECTOR, THIS SHOULD POSE NO PROBLEM FOR THE SPI. THE DIRECTOR WILL COORDINATE WITH THE SPI, THROUGH ITS PRESIDENT. IN ADDITION, THE INSTITUTE BOARD WILL DIRECT AND MONITOR INSTITUTE POLICIES. THIS WILL ELIMINATE THE POSSIBILITY OF CONFLICTS BETWEEN SPI AND INSTITUTE POLICIES. FURTHERMORE, WE SEE NO LEGAL PROBLEMS INHERENT IN THE REPORTING RELATIONSHIP, ASSUMING THAT NORMAL PRECAUTIONS ARE TAKEN, AS THEY WILL BE.

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SLIDE #8

NOW WHERE DO WE GO FROM HERE? ASSUMING AGREEMENT ON THE PART OF THE SPI TO FUNCTION AS THE INSTITUTE'S UMBRELLA ORGANIZATION, WE WOULD PROPOSE THAT AN SPI/INSTITUTE TEAM BE FORMED TO CONSIDER DETAILS OF THE RELATIONSHIP. THESE WOULD INCLUDE PRELIMINARY IDENTIFICATION OF SPI SERVICES NEEDED BY THE INSTITUTE. DETERMINATION OF A MEANS FOR IDENTIFYING COSTS ASSOCIATED WITH SUCH SERVICES. AND CONSIDERATION OF OTHER DETAILS OF THE RELATIONSHIP, FOR EXAMPLE, AVAILABILITY OF SPACE IN SPI OFFICES.

I WOULD NOW BE PLEASED TO ANSWER ANY QUESTIONS YOU MAY HAVE.

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PVC/VCM INDUSTRY ISSUES

VCM

- TRANSPORT
- HEALTH (OSHA/EPA)
- (WASTE DISPOSAL)?

PVC RESIN

- RESIDUAL VCM
- MANUFACTURE HEALTH (OSHA/EPA)
- WASTE DISPOSAL
- GENERAL HEALTH-DUST/FIRE (WHSE)

APPLICATIONS

- FLAME/SMOKE/TOXICITY
- WASTE DISPOSAL
- EXTRACTION
- PLASTICIZER/STABILIZER
- RESIDUAL VCM
- EIR

INDUSTRY GROUPS

- SPI
  - FOOD/DRUG
  - PROFILE EXT. DIVISION
  - P.R. COMMITTEE
  - PPI
  - PVC SAFETY COMMITTEE
  - VINYL SIDING INSTITUTE
  - VINYL WINDOW AND DOOR INSTITUTE
  - PMPD
  - PIPE RESIN PRODUCERS COMMITTEE
  - PAC
    - STATE GOVERNMENT AFFAIRS
    - CCCS
    - ENERGY TASK FORCE
    - PLASTIC RESOURCE RECOVERY AND CONSERVATION COMMITTEE
    - PRODUCT LIABILITY
    - FEDERAL GOVERNMENT AFFAIRS
  - PLASTIC BOTTLE INSTITUTE
  - PLASTIC BEVERAGE CONTAINER DIVISION
  - VINYL FILM GP
  - VINYL FORMULATORS
  - TOXICOLOGY COMMITTEE
  - SHEET PRODUCERS MANAGEMENT DIVISION
- PPFA
- UNIBELL
- RESILIENT FLOORING INSTITUTE
- SPE
- PEG
- CMA

QUALITIES

- REQUISITES
  - RESPONSIVE
  - QUICK
  - DECISIVE
  - KNOWLEDGEABLE
- INDEPENDENT
- DEDICATED STAFF
- OPEN MEMBERSHIP

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MISSION

TO PROMOTE AND PROTECT CONTINUING GROWTH OF THE PVC/VCM INDUSTRY IN THE U.S. AND SERVE THE BEST INTERESTS OF THE PUBLIC BY PROVIDING SOCIALLY VALUABLE PRODUCTS.

OBJECTIVES

- IDENTIFY ALL ISSUES OF POTENTIAL CONCERN TO THE PVC/VCM INDUSTRY.
- PRIORITIZE AND EFFECTIVELY DEAL WITH THESE ISSUES.
- INTERACT WITH OTHER TRADE ASSOCIATIONS TO EFFICIENTLY USE INDUSTRY RESOURCES.
- BECOME THE ORGANIZATION SPEAKING FOR THE PVC/VCM INDUSTRY.

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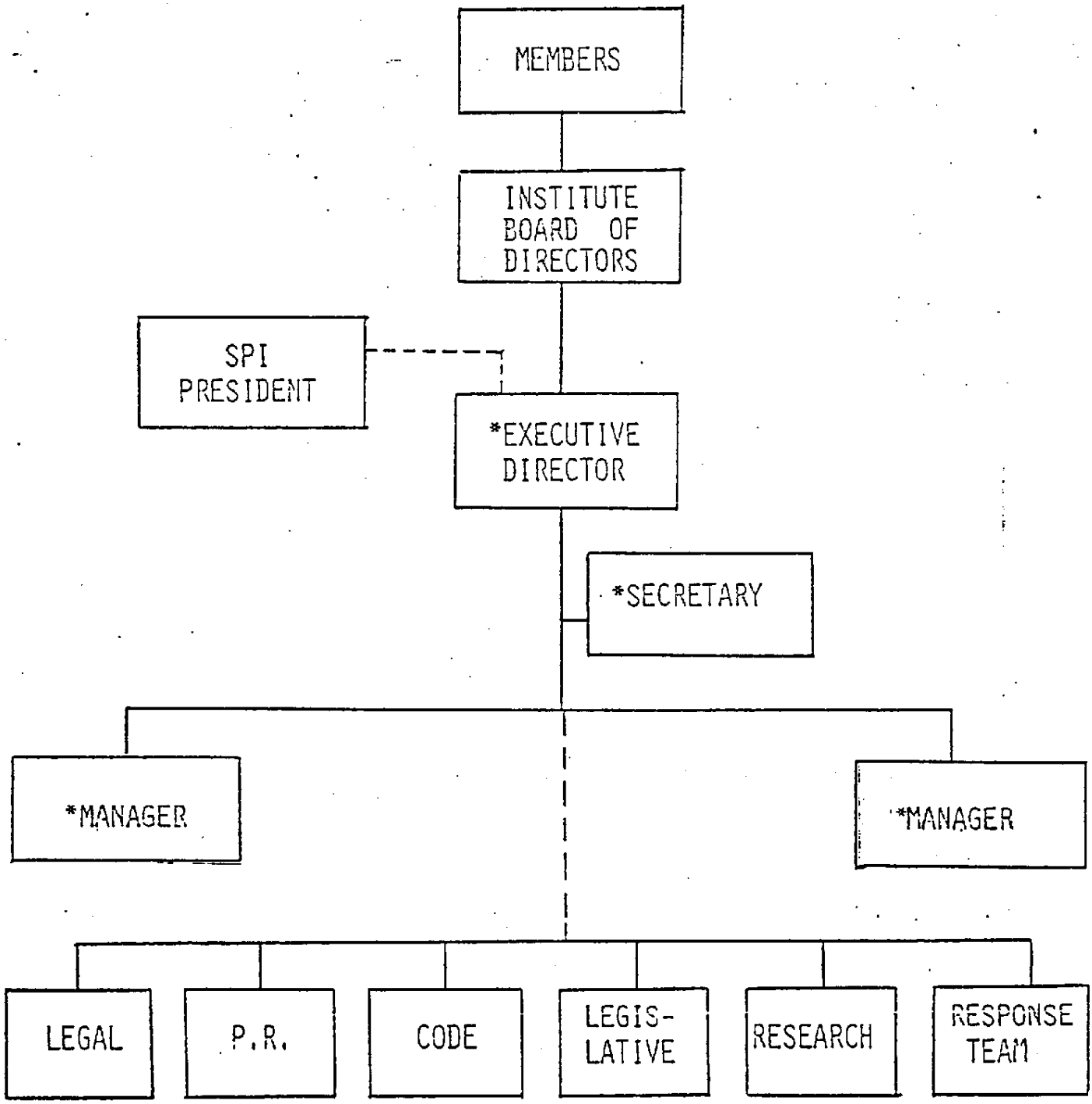
VINYL INSTITUTE



*PERMANENT STAFF

IMMEDIATE ACTION REQUIRED

- RESPONSE CAPABILITY
  - EXPERT TEAM
  - INDUSTRY INFORMATION NETWORK
  - INVESTIGATION (FIRE - EMERGENCY)
  - MEDIA INTERACTION
  - EARLY WARNING SYSTEM
  - AFFIRMATIVE P.R.
- CODE/LOBBYIST GROUP FORMATION
- CALIFORNIA EIR

LONG TERM (CONCURRENT) ACTION REQUIRED

- PUT TOGETHER P.R. "ROAD SHOW"
- ARRANGE FOR POSITIVE PVC ARTICLES AND PAPERS
  - SELECT INDEPENDENT AND INDUSTRY PEOPLE TO PREPARE
  - DECIDE ON AND PREPARE ARTICLES
  - SELECT TARGET PUBLICATIONS
- DEVELOP STRATEGY FOR EXPANDING CODES TO INCLUDE PVC

SPI RELATIONSHIP

- THE INSTITUTE NEEDS SPI SERVICES.
- SPI REVENUES FROM THE INSTITUTE WILL BENEFIT MEMBERS.
- SPI AND THE INSTITUTE WILL ASSURE COMMON FRONT AGAINST THREATS.
- THE INSTITUTE WILL ENCOURAGE SPI MEMBERSHIP.
- REPORTING RELATIONSHIP OF INSTITUTE STAFF WILL PRESENT NO PROBLEMS.

ACTION STEPS

- FORMATION OF SPI/INSTITUTE TEAM.
  - IDENTIFICATION OF SPI SERVICES.
  - DETERMINATION OF METHOD FOR ALLOCATING SERVICE COST.
  - OTHER DETAILS OF THE RELATIONSHIP.

MINUTES

INDUSTRY MEETING - CHICAGO
Tuesday, May 25, 1982

An Industry meeting of VCM/PVC producers was held in Chicago on Tuesday, May 25. Its purpose was to consider formation of a Vinyl Institute whose mission would be to respond to the continuing attacks on PVC, and the growing attempts to restrict its use. In attendance were the following:

Company	Representatives
Air Products	R. C. Sander
Borden Chemical	T. Walker
Certainteed	F. Timpe
Conoco	H. R. Flammer H. J. Hall J. Langford
Diamond Shamrock	J. Long
Dow Chemical	J. Johnson F. Whitley
Ethyl Polymer	C. Montgomery
Formosa Plastics	D. Boller
General Tire	R. Poulin
Goodrich	B. A. DiLiddo T. F. Harrison R. A. Krueger F. C. Smith G. R. Snider L. J. Weisz
Keysor Corporation	E. Scott
Occidental Chemical	R. Gervais A. Mack
PPG	G. Lazarchik J. Thomas
Shell	B. Suthers L. Wheeler
Talleyrand	W. Ware
Tenneco	G. Disch W. Sorenson

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The meeting agenda included Introductory Remarks, by Conoco; a Summary of Recent Events, by Goodrich; a Statement of the Problem, by Tenneco; and a Proposed Organizational Solution by Goodrich. Discussion followed.

Conoco began the meeting by describing the May 5th Washington meeting, attended by Conoco, Dow, Tenneco and Goodrich, which was convened to discuss the severe challenge posed by the increasing attacks on the Industry. At that meeting, it was concluded that a new approach was needed, and it was deemed desirable to meet with all PVC/VCM producers to consider the problem and possible solutions.

Specific examples of problem areas were then drawn to the attention of the group, by Goodrich, using slides and video tapes. These included a description of the efforts of the unions, manufacturers of competitive materials, and their allies, to restrain the use of PVC in plumbing, electrical, and other applications. The various aspects of the challenge in California, New York, and elsewhere were described, as were some of the Industry and Industry Organization responses currently underway. The fact that the Industry can expect recurring anti-PVC campaigns in the future, and that it does not have a reservoir of public and media goodwill to draw on was emphasized.

Tenneco then described in greater detail the nature of the attacks, and the Industry's present posture in addressing them. Principally, the attacks were said to consist of legal suits based on product liability in major fires, and actions designed to disqualify PVC under various codes and standards. The motivation of the attacks was explained. While the Industry was said to be dealing reasonably well with the litigation, such was said not to be the case with the codes/standards problem. The Industry was described as splintered, and incompletely represented in its existing organizations. The response of the SPI has not been a sufficient answer, for which the Industry must assume its share of responsibility. Funding of responses made thus far has been a burden, and it has fallen disproportionately on some members of the Industry. Action on a coordinated basis was said to be essential, while inaction was described as the most costly option.

Goodrich followed with a presentation including a description of issues faced by the Industry, the uncoordinated efforts of the Industry groups to meet the challenge, and the money presently being spent in such efforts. Creation of a Vinyl Institute was proposed, to be not just another organization, but one capable of quick, knowledgeable, and decisive action. It would be an organization free to act in the best interests of both the public and the Industry.

The Institute would have a staff whose only responsibility would be Industry interests, and membership would be open to all PVC/VCM producers. After the Institute is formed, consideration would be given to inviting additive manufacturers to join. Institute resources would include outside organizations, plus committees representing various desciplines staffed by Industry people. Objectives of the Institute would include identification, prioritization, and response to problems and issues, interaction with other trade associations, to be a spokesman for the Industry, and an advocate for the long-term market development of PVC products. The Institute staff, which was described, would report to a Board of Directors. Ideally, it would fit under the umbrella of an existing trade organization. Near-term activity would largely be defensive, but longer term would undertake positive educational, legislative, and code campaigns. The minimal budget for the Institute was estimated at about $525,000, with special assessments from time-to-time for particular purposes. Interim costs incurred prior to the Institute's formation would be rolled into the first year's budget. Funding would include dues for members, relating Institute costs to members' PVC/VCM capacity on a pro rata basis. Copies of the presentation, including accompanying slides were distributed.

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General discussion ensued as follows. While it was agreed that a number of Industry responses to current problems have been organized, these were seen as uncoordinated, and the need for something like a Vinyl Institute which could speak as a single voice for the Industry was recognized. Those present agreed that while the SPI did a good job handling the vinyl monomer problem several years ago, the Industry's problems are more complex today, since they now involve products and applications. Consequently, a different organizational approach is needed. Formation of a Vinyl Institute would permit the marshalling of resources and the concentration of effort needed not only to defend present attacks against PVC, but to structure a positive approach to broaden codes and open up new markets to PVC. Although a number of those present were of the opinion that any of several organizations could act for the Institute as an umbrella organization, the advantage of having the SPI serve in that capacity was recognized, assuming proper terms and conditions can be negotiated. The group believed that the SPI will show flexibility with respect to the question as to whether members of the Institute must also belong to the SPI. The SPI is presently considering how it should structure itself for the '80's, therefore, discussions with it now were seen as timely.

A request for a show of hands to determine those in favor of creating a Vinyl Institute appeared to indicate that there were none present who disagreed with the concept.

It was suggested that an Interim Committee be formed to oversee formation of the Institute. Seven companies were chosen, Certainteed, Conoco, Dow, Goodrich, Occidental, Tenneco, and Shell. Membership on the Committee will consist of higher level management people. Consideration will be given to folding activities of the Ad Hoc Pipe Resin Producer's Committee into those of the Interim Committee. Three or four members of the Interim Committee will meet with the SPI to discuss the possibility of having the latter serve as the umbrella organization for the Institute, and to determine the nature of such a relationship.

The Interim Committee will appoint a Working Committee which will have the responsibility for drawing up an Institute Charter, and of serving as the working arm for the Interim Committee in putting together details of the Institute. Among other things, the Working Committee will be responsible for identifying a response team to respond to Industry challenges. Weisz will coordinate the Working Committee, and members of the Interim Committee will notify him as to the identity of those they wish to have serve on the Working Committee.

A further meeting of those present will be scheduled for July, at which time the Interim Committee will report back regarding the outcome of the discussions with the SPI, and any other matters of interest to the Institute.

Louis J. Weisz

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Chemical releases in area could cause cancer or instant death

By BILL DAWSON

THE AIR WE BREATHE
PART 1

Millions of pounds of toxic chemicals still pour into the air annually from Houston-area industries, 16 years after Congress declared war on air pollution with sweeping changes in the Clean Air Act.

These routine releases include hundreds of tons of substances that may cause cancer. Some of the chemicals also could kill or injure a person immediately if they accidentally escape.

An Environmental Protection Agency study two years ago said toxic chemicals are a bigger health threat in the air than in water or at hazardous waste sites, but the problem was mired in obscurity until December 1984.

Then, in Bhopal, India, a poisonous gas leak killed more than 2,000 people and injured thousands, transforming toxic air pollution into a major environmental issue of the 1980s.

The Bhopal disaster sparked new concerns about the complex problem. Last year, EPA proposed two plans — one for responding to accidents posing immediate danger, another for reducing the leaks and routine releases that may cause cancer and other long-term ailments.

Controversy surrounds both plans. The debate has profound implications for the Houston area, whose sprawling petrochemical complex is the world's largest. An examination of the issue by the Houston Chronicle shows:

- Industrial discharges of toxic chemicals in five counties on the upper Texas coast — Harris, Galveston, Brazoria, Jefferson and Orange — rank among the nation's largest.
- Regulations have forced industry to make substantial reductions in air pollution from a broad group of chemicals that includes many suspected cancer-causing agents and other toxic substances. But the Texas Air Control Board says plants in the five counties still release more than half a billion pounds of these "volatile organic compounds" annually.
- Leading scientists say most chemicals probably do not cause cancer, but eight of 10 chemicals have never been tested or studied enough to make a judgment about long-term health risks.
- Twenty-nine companies in the five counties told a House subcommittee their plants released or had permits to release about 10 million pounds of specific toxic substances in 1984.
- An EPA study said toxic chemicals in the air cause 1,300 to 1,700 cancer cases a year nationwide. Most are caused by small sources like gasoline stations and wood stoves, it said, but people living near large chemical plants are at much higher risk.
- More than 12,000 accidental releases of toxic chemicals and other air pollutants — or plant conditions with the potential for that to happen —

See EPA on Page 12.

Continued from Page 1.

were reported to the state by companies in the five counties since 1980.

- Regulations allow a hodgepodge of safeguards — sometimes differing for the same chemical at two units of the same plant — but company and government officials say a catastrophic release is unlikely because of the chemical industry's good safety record.
- An EPA-commissioned study last year compiled a partial listing of toxic chemical accidents since 1980 in selected areas, including Texas. There were at least 6,928 such accidents that killed 130 people and injured 1,478.

To prepare for immediately dangerous leaks, EPA has developed a significant new program to give state and local officials guidance, EPA Administrator Lee Thomas said. But critics say it does nothing to require industry to prevent accidents.

Thomas

To combat cancer and other chronic risks, EPA is boosting its effort to set regulations for more chemicals than the "very limited" number with controls so far, Thomas said. But critics say EPA's regulation-setting process weakens protection of public health. And state officials in Texas and elsewhere doubt they can handle new duties required by the EPA plan.

The debate is complicated because government agencies know relatively little about toxic air pollution — specific chemicals released, volumes and long-term hazards.

All air pollutants are "toxic" by definition, but that term is widely used to designate substances that may pose immediate or chronic risks — sometimes both — even at very low levels. They include chemicals like methyl isocyanate, chlorine, benzene, vinyl chloride, phosgene and hundreds of others.

The "toxic" name also distinguishes these substances from six more common air pollutants that Congress specifically ordered EPA to attack because they are found widely throughout the country — ozone, carbon monoxide, airborne particulates, sulfur dioxide, nitrogen dioxide and lead.

One indicator of the magnitude of toxic releases in this area is the Texas Air Control Board's recent estimate that industries in the five industrial counties around Houston annually release 666 million pounds of chemicals in the broad group of "volatile organic compounds." These "VOCs" number in the thousands and include many of the substances commonly called "toxic" and many suspected cancer-causers.

"I can't conceive of a place with a lot of VOC emissions that doesn't have a lot of the VOCs that cause cancer," said Bern Steigerwald, an EPA air official.

Industry has been required to reduce emissions of volatile organic compounds, as a group, because some of them help form ozone, which is one of the six priority pollutants and an ingredient of smog.

But research about most of these organic chemicals is too limited for scientists to add them either to the relatively short list of those that may cause cancer or to the longer list of those without that ability. A National Academy of Sciences committee said in 1984 no research had been done on the long-term risks of 70 percent of the 60,000 to 70,000 chemicals Americans are exposed to. Another 14 percent had been studied somewhat, but not enough to estimate risks.

Last year, the House Health and Environment Subcommittee said it was making the broadest effort ever to find out about releases of individual toxic chemicals. The panel asked 86 large chemical companies what amounts they release, if any, of specified substances and others with similar hazards. Twenty-nine companies in the five Houston-area counties responded to the inquiry.

An analysis of the responses shows plants in those counties released — or had permits to release — about 10 million pounds of 45 of these chemicals in 1984. More than 2.5 million pounds were chemicals known or suspected to cause cancer. Almost 6 million pounds were chemicals that EPA says can kill or injure if a large enough amount escapes into the air.

The Texas Air Control Board says about 350 companies (and a few government agencies) with 491 facilities in those counties have permits to release volatile organic compounds.

Toxic releases here were compared with those in other areas in an EPA study in 1984. The study summarized what was known about sources and amounts of 86 potentially toxic air pollutants. They were mainly estimated from production figures, because EPA's data base about the actual volumes released is poor.

Virtually all of about half of these 86 substances enter the air from organic chemical plants, the study said, and the most striking aspect of their location was the large concentration between Corpus Christi and New Orleans. Eighteen of the chemicals were made entirely in Texas and Louisiana, with more than half the production of another 47 in the two states.

It appears that the Texas-Louisiana and the Philadelphia-New Jersey areas, where chemical plants are also concentrated, have the nation's largest totals of industrial releases of toxic chemicals to the air, Steigerwald said.

In the past six years, the 12,000 reports to Texas officials that described unintended releases — actual and potential — involved immediately dangerous toxic chemicals, others that may pose long-term risks and some fitting both categories, as well as other kinds of pollutants.

State officials say the reports as a group are as significant for what they omit as for what they tell. In many cases, companies left out the identity of pollutants released, the amount, or both. Texas and Houston-area environmental releases are never reported, but that a catastrophic release is a remote possibility.

Jim Myers, TACB's enforcement chief, said federal work-place safety regulations and an aggressive effort by companies make the chance of a disastrous release a smaller concern for Texans than the possible long-term harm of routine releases.

Jon Fisher, research director for the Texas Chemical Council, said safety efforts are evident in the industry's low injury rate. The injury record of Texas chemical plants is five times better than the chemical industry's in the United States, he said, and 10 times better than that of all American manufacturers.

Industry generally adopts safety procedures voluntarily, said Lewis Crampton, executive director of the National Institute for Chemical Studies in Charleston, W. Va. "The chemical industry is highly regulated except in one area, actual production. Products are regulated, but the production process itself is not overly regulated," he said. "There are no real standards for process safety."

Some Texas and Houston-area officials gave a lukewarm reception last fall to EPA's new plan to help them prepare for disastrous toxic releases, saying they were probably already doing most of what it recommends.

Thomas said the program will increase awareness about highly toxic chemicals and preparedness for accidents. It is not a criticism of state and local officials, he said, but showed "that we, EPA, didn't feel we were adequately responding to the potential threat and we did have a responsibility in that area.

"It also reflected that the primary responsibility for responding to any kind of emergency as well as developing the plans was a state and local responsibility, but we had a significant role in providing technical information and technical support."

Along with advice for preparedness, EPA provided profiles of 402 chemicals that can kill or injure in an air release.

Bill Gulledge, associate environmental director of the Chemical Manufacturers Association, said EPA's effort will complement CMA's similar Community Awareness and Emergency Response program, developed and introduced after the Bhopal accident.

Critics of EPA's acute hazards plan, however, say it should formally require efforts to prevent catastrophic releases.

David Doniger, senior attorney for the Natural Resources Defense Council, said the list of 402 chemicals is useful, but should also include substances posing only long-term risks. EPA's reliance on state and local governments is worrisome, he said, because they often hesitate to seem "too pushy" with major corporations, so their area will not get a reputation of having "a bad business climate."

Thomas said EPA's plan for immediately dangerous releases will produce "a lot of public awareness, a lot of

public pressure, a lot of regulatory pressure on the plant manager" to avoid accidents, which will prompt a continuing review of production processes and also reduce routine releases.

Doniger said procedure changes are essential, but so is abandonment of "the 19th century plumbing the chemical industry now uses."

There is no "bright line," dividing steps to prevent accidental and routine releases, he said. "The first thing you have to do is adopt an ethic or approach that the objective is to stop using the air as a hazardous waste dump and to make these processes totally closed."

Gulledge, of the Chemical Manufacturers Association, said, however, that although the industry strives to reduce releases, "zero emissions are just not possible." Chemical plants, he said, "have to emit things to the air" in some circumstances.

Cost has something to do with it, " he said. "You could cut down, but spend an absolute fortune on it." The technology is not available to stop all routine releases, he said. And chemical processes are "designed for emissions at permitted safe levels."

Just how those "safe levels" are determined is at the heart of the complex debate over EPA's plan to improve control of routine releases.

The Clean Air Act amendments of 1970 specified five priority pollutants for reduction around the country, and Congress added a sixth — lead — to that list in 1978.

Congress also told the new EPA 16 years ago to regulate other air pollutants — called "hazardous" in the act, but also known as "toxic" — that increase death or injury. To date, EPA has set regulations for six — mercury, beryllium, asbestos, vinyl chloride, benzene and radionuclides — but environmentalists say all major sources are not covered and the controls that were required were not as good as some companies already used.

EPA officials concede the program has moved too slowly.

Doniger and other critics in the environmental movement and Congress say EPA overcomplicated that process — and weakened its protection against cancer and other ailments — when it started asking if pollution controls were technically feasible and comparing their costs with the monetary value of the lives they would save.

EPA at first issued regulations to reduce releases of specific toxic air pollutants basically because a substance was dangerous, but an intense counterattack by industry prompted the agency to start the detailed process of deciding just how dangerous each one is and how many people are threatened. This was done to fend off lawsuits, the U.S. General Accounting Office said in 1983.

Myers said EPA has "gone along at a snail's pace" because industry "has fought tooth and claw to roadblock that program."

THE AIR WE BREATHE

Today

Millions of pounds of toxic chemicals still flow into the air annually from industries on the upper Texas coast. The Environmental Protection Agency's plans to prevent long-term health problems and prepare for accidental leaks are both controversial.

Monday

West Virginia's Kanawha Valley — the "Chemical Valley" — has come face to face with the threat of toxic air pollution like no other American community. Residents are divided — can they have jobs and safety?

Tuesday

Officials say most chemicals that can kill or injure in accidents are found in the Houston area. One of the deadliest has leaked several times in recent years, sometimes floating beyond plant boundaries. Companies are taking extra precautions.

Wednesday

Uncertainties surround the debate over toxic chemicals' long-term risks. Routine releases usually translate into tiny or undetectable levels in the air. What risks do they pose? Scientists are only starting to put the puzzle together.

Thursday

EPA officials say they must concentrate on the toxic air pollutants with the biggest long-term risks. Critics say that may leave some pollutants unregulated and some Texas residents unprotected. Is it acceptable for some people to face pollution risks involuntarily?

Gulledge, spokesman for the chemical industry, said it "obviously will participate in the regulatory process and comment."

Whatever the reasons, Thomas said he is now speeding up and enlarging the program. That strategy is based largely on a controversial EPA study that looked at 40 chemicals and arrived at the rough estimate that they cause 1,300 to 1,700 cancer cases yearly in outdoor air in the United States.

Small sources of pollutants, such as the fumes from pumps at gasoline stations, cause most of those cancers, because they are more widespread than big industrial sources, such as chemical plants and refineries, the study said.

Some people downplay the significance of health risks from industrial releases, citing that finding and another EPA study that said most people are exposed to higher levels of toxic chemicals in indoor air than outside, even living near chemical plants.

Jim Price, research director of the Texas Air Control Board, said advocates of tighter industrial controls are often "haggling" and "quibbling," because the EPA study said more pollutants come from small sources.

But Steigerwald, an author of the study, said large chemical plants pose much greater hazards for people nearby. "I'd personally be more concerned about being in an area of high individual risk" than about living near one of the small sources, he said.

Some critics say EPA is using the study to back away from industrial controls, but Gulledge said the finding of higher risks around chemical plants suggests otherwise.

Thomas said EPA will give more attention to regulating small sources than in the past, but not at the expense of industrial controls. It is allocating more funds to set four times as many regulations per year than were imposed on industrial pollutants in the past, he said.

Speeding up the program also involves "referring" some chemicals to the states that EPA determines come from only a few industrial sources and do not warrant the expense and effort to set a federal regulation, he said.

To help the states set regulations, he said, EPA will provide increased funding and its own extensive technical resources to help determine risks and what controls are needed.

Despite such promises, the "state referral program" has proven highly controversial. Critics fear that states lack the resources to handle the complex task and may impose lax regulations, if any, to keep from driving away industry.

Texas regulations now involve three tiers of controls. "Reasonably available" technology is required for all sources of volatile organic compounds. "Best available" technology — a step up in control — must be in place on new and modified air pollution sources. Even tighter controls are required for specific toxic chemicals with federal regulations.

State officials doubt they have the resources to set regulations for individual chemicals. "We would be imprudent to say we could do it all," said Eli Bell, who becomes executive director of the Air Control Board in March.

"I think we feel strongly about the control of toxics. We will look for every

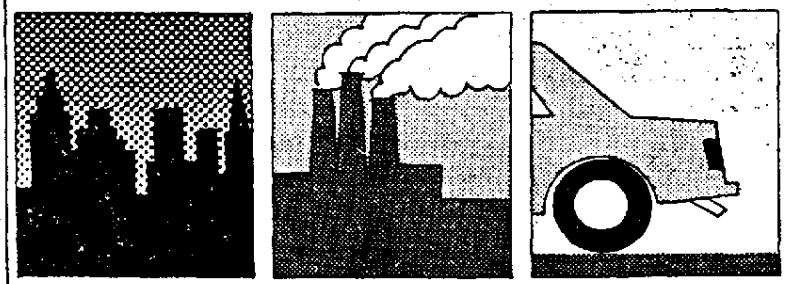
way we can to shift resources into that area, but there's a lot of other work we have to do in response to the (1985) amendments to the Texas Clean Air Act. Given the list I've seen (of chemicals likely to be referred to Texas), we'd be hard pressed to get it all done."

Other TACB officials were more blunt. Myers said EPA seems to be saying their record "looks awful" and "they're going to try to get money to give us to let us do it. They're kind of passing the hot potato down."

Next: Jobs vs. safety: A West Virginia community comes face to face with the divisive specter of toxic air pollution.

COMMON AIR POLLUTANTS

Federal regulations for six major air pollutants found widely around the country are separate from regulations for "toxic" or "hazardous" pollutants. The six major pollutants; estimated annual industrial releases in Harris, Galveston, Brazoria, Jefferson, Orange counties; health concerns, and non-industrial sources:



Ozone — Volatile organic compounds (666 million pounds) and nitrogen oxides (1 billion pounds) help form ozone, major ingredient of smog. Respiratory problems, eye irritation, reduced resistance to infection. Automobiles also emit VOCs, nitrogen oxides.

Nitrogen dioxide — The nitrogen oxides total is mainly nitrogen dioxide, but includes some nitrogen oxide. Respiratory illness, lung damage.

Airborne particulates — 108 million pounds (a combination including dust, fly ash, metals, smoke, mist). Eye and throat irritation, bronchitis, lung damage. Automobiles are another source.

Carbon monoxide — 1.1 billion pounds. Impaired ability of blood to carry oxygen; cardiovascular, nerve, pulmonary problems. Automobiles are another source.

Sulfur dioxide — 651 million pounds. Respiratory problems, permanent lung damage.

Lead — 108,000 pounds. Retardation and brain damage, especially in children. Automobiles using leaded gasoline are another source.

Sources: Environmental Protection Agency, Texas Air Control Board.

Ronald L. Goins / Chronicle

TOXIC CHEMICALS IN THE AIR

The House Health and Environment Subcommittee asked major chemical companies last year to report on toxic chemicals they release to the air. The list below includes amounts of 31 of 45 substances that responding companies said they released or had permits to release in Harris, Galveston, Brazoria, Jefferson and Orange counties. Totals were given as 1984 or annual volumes.

The list does not reflect all Houston-area releases of toxic pollutants. For example, about 40 companies in the five counties — many of them not chemical manufacturers — have state permits to release benzene, which the Environmental Protection Agency says is a known human carcinogen.

Some companies told the subcommittee releases were being substantially reduced. Exxon reported large reductions in all emissions at its Baytown chemical plant. B.F. Goodrich said there would be no emissions of ethylene dichloride at La Porte and 1.9 tons of butadiene released at Port Neches last year. Shell said benzene emissions would be cut almost in half in 1985. W.R. Grace said formaldehyde releases at Deer Park would be reduced to less than 0.4 tons in 1985.

(1) Known human carcinogen, according to EPA.

(2) Probable human carcinogen, according to EPA.

(3) Some evidence of cancer-causing ability, according to EPA.

(4) Carcinogen, according to National Institute of Occupational Safety and Health.

(5) Chemical that can kill or injure if accidentally released to the air in large enough amounts, according to EPA.

ACROLEIN (5)

11.47 total tons released

Company	Plant location	Tons released
Monsanto	Alvin	1.8
Monsanto	Texas City	3.6
Rohm and Haas	Deer Park	6.07

ACRYLONITRILE (2) (5)

206.22 total tons released

Company	Plant location	Tons released
Du Pont	Beaumont	20.22
Goodyear Tire & Rubber	Houston	6
Monsanto	Alvin	120
Monsanto	Texas City	60

AMMONIA (5)

1,959.97 to 1960.07 total tons released

Company	Plant location	Tons released
Du Pont	Sabine River	1,919.2
Dow Chemical	Freeport	less than 0.1
Goodyear Tire & Rubber	Houston	6.2
Monsanto	Alvin	18.3
Monsanto	Texas City	9.4
Rohm and Haas	Deer Park	6.87

ANILINE (5)

Company	Plant location	Tons released
Du Pont	Beaumont	16.93

FORMALDEHYDE (3) (5)

10 to 14.8 total tons released

Company	Plant location	Tons released
Exxon Chemical	Houston Chemical	0.5
W.R. Grace & Co.	Deer Park	less than 4.8
Monsanto	Alvin	9.5

HYDROCHLORIC ACID (5)

0.43 total tons released (Hydrogen chloride in water solution)

Company	Plant location	Tons released
Exxon Chemical	Houston Chemical	0.03
Mobil	Beaumont Chem. Specialties	0.4

HYDRODGEN CHLORIDE (5)

6.21 to 6.31 total tons released

Company	Plant location	Tons released
Du Pont	Beaumont	4.9
Du Pont	Sabine River	0.01
Dow Chemical	Freeport	less than 0.1
Monsanto	Texas City	1.3

HYDROGEN CYANIDE (5)

39.89 total tons released

Company	Plant location	Tons released
Du Pont	Beaumont	0.3
Monsanto	Alvin	19.8
Monsanto	Texas City	12.9
Rohm and Haas	Deer Park	6.89

HYDROGEN FLUORIDE (5)

Company	Plant location	Tons released
Monsanto	Alvin	0.4

BENZENE (1)
553 total tons released

Dow Chemical	Freeport	7.9
Exxon Chemical	Baytown Olefins	28
Exxon Chemical	Baytown Chemical	10
Goodyear Tire & Rubber	Bayport	0.1
Shell Chemical	Deer Park	507

BUTADIENE (2) (5)
113.3 total tons released

B.F. Goodrich	Port Neches	11.7
Denka Chemical	Houston	1.6
Goodyear Tire & Rubber	Houston	100

CARBON TETRACHLORIDE (2)

Dow Chemical	Freeport	37.3

CHLORINE (5)
391.761 total tons released

ARCO Chemical	Port Arthur	0.1
Denka Chemical	Houston	unmeasured
Du Pont	Beaumont	0.66
Dow Chemical	Freeport	340
Shell Chemical	Deer Park	51
Velsicol Chemical	Beaumont	0.001

CHLOROFORM (2) (5)
83.13 to 88 total tons released

Du Pont	Beaumont	83.13
Allied Corp.	Orange	less than 4.87

CHLOROPRENE (4)

Denka Chemical	Houston	50

EPICHLOROHYDRIN (2) (5)

Shell Chemical	Deer Park	16.4

ETHYLENE DICHLORIDE (2)
30.7 to 30.8 total tons released

B.F. Goodrich	La Porte	12
ARCO Chemical	Port Arthur	9
Dow Chemical	Freeport	less than 0.1
Shell Chemical	Deer Park	0.1
Velsicol Chemical	Beaumont	9.6

ETHYLENE OXIDE (2) (5)
7.224 total tons released

Exxon Chemical	Houston Chemical	6.4
Rohm and Haas	Bayport	0.044
Rohm and Haas	Deer Park	0.78

HYDROGEN SULFIDE (5)

Du Pont	Beaumont	0.0009

METHYLENE CHLORIDE (2)

Monsanto	Alvin	130

METHYL ISOCYANATE (5)

Velsicol Chemical	Bayport	less than 0.2

METHYL MERCAPTAN (5)
1.41 total tons released

Du Pont	La Porte	0.01
Monsanto	Alvin	1.4

NITRIC OXIDE (5)

Denka Chemical	Houston	3.8

PERCHLOROETHYLENE (2)

Dow Chemical	Freeport	36.8

PHENOL (5)
22.57 total tons released

Monsanto	Alvin	11.1
Monsanto	Texas City	0.2
Rohm and Haas	Deer Park	0.27
Shell Chemical	Deer Park	11

PHOSGENE (5)

Velsicol Chemical	Bayport	less than 0.2

PROPYLENE OXIDE (3) (5)
41.458 total tons released

ARCO Chemical	Bayport	35
ARCO Chemical	Channelview	1
Exxon Chemical	Houston Chemical	5.4
Rohm and Haas	Bayport	0.058

STYRENE (3)

Goodyear Tire & Rubber	Houston	50

SULFURIC ACID (5)
8 total tons released

Du Pont	La Porte	7
Goodyear Tire & Rubber	Houston	1

TRICHLOROETHYLENE (2)

Dow Chemical	Freeport	less than 0.1

VINYLIDENE CHLORIDE (3)

Dow Chemical	Freeport	0.9

EPA says it intends to regulate butadiene, carbon tetrachloride, chloroform, ethylene dichloride, ethylene oxide, methylene chloride, perchloroethylene and trichloroethylene. The Natural Resources Defense Council is suing to speed up the EPA effort. The agency says it will not regulate acrylonitrile, chloroprene, epichlorohydrin and vynilidene chloride.

Long-term effects of tiny chemical levels unknown

By BILL DAWSON
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Carlos Stokes never worked in a chemical plant, but he lived near four of them in Port Neches for 13 years before he died of leukemia at the age of 25.

When 12 companies paid his widow an undisclosed sum to settle a lawsuit in 1984, it was a remarkably rare occasion. It was about as close as the petrochemical industry comes to conceding that its routine releases of millions of pounds of toxic substances can hurt anyone.

Many leading scientists say, however, that despite environmental and work place regulations to reduce the amount of those chemicals in the air, evidence suggests some of them cause cancer. Major reports by the Environmental Protection Agency and a blue-ribbon panel of the National Academy of Sciences recently shared that assumption.

THE AIR WE BREATHE
PART 4

Even so, the issue of toxic air pollution's chronic health risks remains fraught with controversy and uncertainty.

No one denies catastrophic releases of highly toxic chemicals can injure or kill people outside plants. But experts constantly debate the long-term effects of tiny levels of chemicals in the air — like the ones that Stokes' widow, Mary Ellen Reeves, believes killed him.

Stokes moved to Port Neches when he was 10, a decade before Congress mounted a major attack on air pollution with changes to the Clean Air Act. He graduated in 1968 from Port Neches-Groves High School, a half-mile from three plants. After two years in the Army, he returned to the city and learned in 1972 he had cancer. He died two years later, leaving two children.

In 1979, Reeves read about a lawsuit charging air pollution from four plants had caused workers' leukemia. Lawyer William Townsley had also discovered several leukemia cases among men who were students at Port Neches-Groves around the time Stokes attended. Reeves joined the lawsuit, which said chemicals in the air endangered workers and residents.

Stokes was the only plaintiff who had not been a plant worker. In the settlement of the case, 12 companies that had operated or provided chemicals to the four plants agreed to make payments to his family, relatives of three workers who had died and one surviving former worker.

Reeves thinks the lawsuit helped plant workers, because several told her their companies increased health test-

See EFFECT on Page 9.

Continued from Page 1.

ing for employees.

Although they settled the lawsuit, the companies never admitted harming the leukemia victims, Townsley said. And the Texas Department of Health investigated in 1979 and found "no reason to believe" attending Port Neches-Groves increased a person's leukemia risk.

Townsley was not satisfied with that study and wanted the U.S. Centers for Disease Control to do another one, but said the Health Department would not make the needed request.

Epidemiological studies, the type done at the school, use statistics to search for patterns and possible causes of disease in large groups. They look for relationships between disease and factors such as family history, personal habits and exposure to harmful substances at work or in the environment.

But epidemiology has not given definitive answers about air pollution's relationship to lung cancer death rates on the upper Texas coast, which are significantly above rates in the rest of Texas and the nation. A three-year epidemiological study, finished in 1983, could not establish or rule out air pollution as a cause of some lung cancer deaths in Harris County, the principal investigator said at the time.

The National Academy of Sciences issued a report last fall that emphasized epidemiology's limitations in weighing toxic air pollutants' role in cancer and other health problems. But it said evidence from several lines of scientific research about all types of air pollution points to the conclusion that it still causes "substantial adverse health effects in some segments of the U.S. population." Among other conclusions:

- While smoking causes most lung cancer, it is "plausible" that air pollution causes or contributes to an unknown number of cases, for several reasons. Cancer-causing chemicals are found in urban air. Studies indicate chemicals taken from polluted air cause tumors in laboratory animals. And a number of epidemiological studies suggest a link between lung cancer and carcinogens in the air.
- "Volatile organic compounds" — which are released by petrochemical plants and refineries and also come from sources including automotive exhausts, pumps at gasoline stations and household chemicals — are an "emerging" concern for scientists, because some may cause cancer, mutations or nerve damage in the public.
- More health studies have been performed about benzene than any other volatile organic compound. Epidemiological studies indicate it caused leukemia in some rubber and chemical workers. But there is no proof it causes cancer in the general population, and the limitations of such studies make it unlikely they can ever offer proof.

One of the largest of those problems is what scientists call "confounding variables" — the factors such as family history, personal habits and occupational chemical exposure that may play an unknown or unmeasurable role in a case of cancer.

Often, scientists establish that a chemical causes cancer only because that cancer is rare, said Marvin Legator, director of environmental toxicology at the University of Texas Medical Branch at Galveston and a member of the National Academy of Sciences panel.

"Unfortunately, most carcinogens don't cause rare tumors, they just cause an increase in common tumors," Legator said, and scientists face a daunting task in separating the ones caused by environmental pollutants from those with other causes.

"Our ability to get epidemiological data on most chemicals is almost nil," Legator said. "The classic example is cigarette smoking. It took since 1955 to the present time, with hundreds of millions of dollars being spent, and the tobacco industry is still arguing that it's just a statistical fluke."

Bern Steigerwald, co-author of a study that heavily influenced EPA's new strategy to reduce the chronic risks of toxic air pollutants, said his agency seldom uses epidemiological studies to assess hazards and whether to regulate them.

In an admittedly rough estimate, the EPA study said toxic air pollution outdoors causes 1,300 to 1,700 cases of cancer a year nationwide. Chemicals from small but numerous sources, such as automobiles, gasoline pumps and wood stoves, cause most of those cases, the study said, but people living near industrial sources such as chemical plants generally have larger individual risks.

To gauge a chemical's cancer hazard, EPA first estimates its capacity to cause the disease at different doses, usually from the results of animal tests. Then comes an elaborate statistical process using that figure and others to indicate how much goes into the air, how much comes from tall stacks and ground-level leaks, weather patterns and data about the surrounding population.

For example, EPA says the cancer risk from constantly breathing 1 microgram of acrylonitrile per cubic meter of air over 70 years is about seven in 1 million. The agency has tentatively decided not to regulate the chemical federally, but it is cooperating in studies with several states where it is released, including Texas, to help them decide whether to impose state controls.

Critics say great uncertainty can surround every number used in EPA's risk calculations. Steigerwald conceded he has much more confidence in the numbers EPA assigns to the cancer risks of some air pollutants than in others.

Another puzzling area is the question of "synergism" — whether chemicals in the air do more harm combined with each other or with tobacco smoke than they do separately. Regulations are generally based on their separate effects.

"The basic problem is that we hardly know what most of the compounds put into the air do on an individual basis, so it's hard to talk of synergism," said Philip Landrigan, environmental medicine professor at Mount Sinai School of Medicine in New York City.

"People are always exposed to a mixture of pollutants. Almost certainly, there are cumulative effects," said Landrigan, vice chairman of the panel that produced the National Academy of Sciences' air pollution report.

That report said scientists must learn air pollution's role in causing lung cancer because it may combine with smoking and other factors to increase the number of cases. Perhaps some of that increased cancer risk can be prevented by reducing exposure to chemicals in the air, the report said.

Robert Phalen, professor of community and environmental medicine at the University of California at Irvine, studies what air pollutants do to laboratory animals and has noted several combined effects.

Sulfur dioxide — discharged by some Houston-area industries in large volumes — can produce slow, deep breathing and overwhelm bodily defenses against other pollutants, Phalen said. And volatile organic compounds can combine with each other into different compounds, which in turn can easily react with still other harmful pollutants like ozone, he said.

Landrigan said volatile organic compounds are an "emerging" problem because so little is known about chronic effects. Only in the last five years or so have scientists learned some of these hundreds of chemicals can cause brain damage in people exposed at work, he said, and they will have to do more research before they can say what that finding implies for the public.

Daniel Menzel, a Duke University toxicologist who serves on EPA's Science Advisory Board, said researchers have been worried about volatile organic compounds for several years, but more was known about other pollution problems, which got attention first.

"We have a blank on the health effects of many chemicals, because they're intermediates, the stuff that's being used to make something else," he said. "There are always inefficiencies in any chemical process and you end up with this guck. It's of no commercial value. A company has no incentive to investigate the toxicity of that compound, because they're throwing it away."

Phalen noted other unanswered ques-

tions: Why is one person affected by exposure to a chemical that does not affect others? What is the role of exercise, in light of evidence it can multiply air pollutants' risks? What are the relative roles of outdoor air pollution and the higher levels of many of the same substances indoors?

A 1984 EPA report said toxic air pollutants may affect people in ways other than inhalation. "Indirect exposure may occur after airborne particles fall to earth and are taken up by crops, animals or fish that we consume. These particles may also contaminate the water we drink."

All the uncertainties complicate the ultimate policy question of how tightly to control toxic chemicals that still flow regularly into the air. Or, as some put it, how safe is safe?

Vincent Guinee, head of epidemiology at the University of Texas M.D. Anderson Hospital, conceded studies about cancer patterns in large groups — his specialty — do not give easy answers. But as a public health physician, he believes officials must act on what they know.

Most people already think pollutants should be removed from water — even without definite proof they are hurting anyone — and should view air pollution the same way, he said. "We don't do that with water. If it looks bad and smells bad, we want it cleaned up. It's a perfect parallel."

Other scientists, such as Phalen and Menzel, cautioned that incomplete information can lead to "overcontrol" of industry, and regulations should be balanced against what Menzel called "the comforts of life" provided by the chemical industry — an enormous variety of products ranging from plastics to synthetic fibers to drugs to agricultural chemicals.

Opponents of tighter controls on industry sometimes argue that smoking poses a much larger health hazard than air pollution. But Phalen said involuntary risks like breathing industrial pollutants differ ethically from the risks a person chooses voluntarily, and society must treat them differently.

"It's a fundamental social question, whether chemicals ought to be innocent until they're proven guilty, or the opposite," said Landrigan, a former official of the National Institute for Occupational Safety and Health.

"Since they're artificial, manmade additions to the environment, I think they ought to be screened very carefully. The burden of proof ought to be on the manufacturer to prove a chemical is harmless, rather than the other way around. It comes down to one's overall view of life. As a physician, my view is that life should be preserved and prolonged."

Next: Will EPA's new strategy to combat cancer-causing chemicals in the air leave some Texans unprotected?

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THE AIR WE BREATHE

Sunday

Millions of pounds of toxic chemicals still flow into the air annually from industries on the upper Texas coast. The Environmental Protection Agency's plans to prevent long-term health problems and prepare for accidental leaks, are both controversial.

Monday

West Virginia's Kanawha Valley — the "Chemical Valley" — has come face to face with the threat of toxic air pollution like no other American community. Residents are divided — can they have jobs and safety?

Tuesday

Officials say most chemicals that can kill or injure in accidents are found in the Houston area. One of the deadliest has leaked several times in recent years, sometimes floating beyond plant boundaries. Companies are taking extra precautions.

Today

Uncertainties surround the debate over toxic chemicals' long-term risks. Routine releases usually translate into tiny or undetectable levels in the air. What risks do they pose? Scientists are only starting to put the puzzle together.

Thursday

EPA officials say they must concentrate on the toxic air pollutants with the biggest long-term risks. Critics say that may leave some pollutants unregulated and some Texas residents unprotected. Is it acceptable for some people to face pollution risks involuntarily?

Mobile lab to tour city checking on pollutants

A mobile laboratory may soon be rolling through the streets of Houston, loaded with equipment to measure the air for toxic chemicals and packed with cages containing dozens of mice to breathe the pollutants.

It is part of an ambitious project by the Texas Air Control Board's research staff to learn if toxic air pollution poses long-term health hazards for people living along the upper Texas coast.

After months of preparation, the agency began in October to check the Houston air for 10 selected chemicals and chemical groups among the dozens that industries release here. The monitoring site is in the Cloverleaf area near Houston Ship Channel industries.

The research plan calls for one year of monitoring in Harris County, then a year of measurements in three other counties where refineries and petrochemical plants are concentrated — Galveston, Jefferson and Orange.

The findings will go a long way toward answering some persistent questions. Officials know that industries in this area routinely release millions of pounds of toxic chemicals each year, but they have relatively little data to pinpoint the levels actually present outside the plants. Because most of those substances are not specifically regulated, government agencies have not had continuing programs to measure them.

The measurements that the Air Control Board is making represent an important step. But there are serious limitations to what that information will reveal about the risks of breathing those chemicals, especially combinations of them, said Jim Price, TACB's research director.

That is where the mobile lab will help, if the agency proceeds with the idea as planned. Marvin Legator, director of environmental toxicology at the University of Texas Medical Branch at Galveston, designed a research plan to expose laboratory mice to combinations of toxic air pollutants. The mice then would be studied to see if they have any adverse health effects, such as genetic damage that might indicate precancerous changes.

At this early stage in the project, Legator and Price have differing views on the risk of toxic chemicals in the air along the Texas coast. Regarding the cancer-causing potential of some of those substances, Legator said, "Whatever we see in industrial populations is just an exaggeration of what we see in the general population."

By contrast, Price believes the measurements recorded so far at the Cloverleaf site suggest there is not a major risk because of the controls that the agency requires for new and modified pollution sources. Those controls normally reduce community exposure to toxic chemicals to levels many times lower than those required by federal regulations to protect workers, he said.

— BILL DAWSON

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Magazine

A REPORTER AT LARGE

THE ENVIRONMENT

IN the past few decades, the United States has witnessed a series of remarkable popular movements, the most prominent being the movements for civil rights, for the equality of women, for peace, and for the environment. People who have participated in these efforts are prone to reflect after a time on what has been accomplished. In the case of the civil-rights, women's, and peace movements, this is a subtle task, involving social processes that are not readily converted to "objective" numerical trends. To assess the impact of the environmental movement is easier, for the quality of the environment can be expressed in terms of generally unambiguous measurements: the changes, since the birth of the movement, in the amounts of harmful pollutants in the air or the water, or, for that matter, in our bodies; in the populations of fish or birds that have suffered environmental harm; in the efficacy of control measures.

The environmental movement is old enough now—its birth can be dated from the enthusiastic outburst of Earth Day, in April of 1970—to be held accountable for its successes and failures. Having made a serious claim on public attention and on the nation's resources, the movement's supporters cannot now evade the troublesome, potentially embarrassing question: What has been accomplished? Concern with the environment and efforts to improve it are today worldwide, but the United States is the place where the environmental movement first took hold, and where the earliest efforts were made, so it is a good place to look for answers. Since the early nineteen-seventies, the country has had basic laws that are intended to eliminate air and water pollution and to rid the environment of toxic chemicals and agricultural and urban wastes. National and state environmental agencies have been established; billions of dollars have been spent; powerful environmental lobbies have been created; local organizations have proliferated. Environmental issues have taken a permanent place in our political life.

In one respect, all this activity has clearly achieved an important success: we now know a good deal more about the state of the environment than we used to. In the last fifteen years, the United States has established monitoring systems that record the annual changes in environmental quality, and these give us an indication of what has happened in the environment since the effort to improve it began. The amounts of different pollutants that are emitted into the environment each year can be estimated fairly accurately for the nation as a whole from technical data on the behavior of cars, power plants, factories, and farms, though such measurements do not reveal the levels of pollutants that people actually encounter, which may differ a great deal, depending on how far they live from the pollutants' source. Local concentrations of some common pollutants—for example, the amount of dust or sulfur dioxide per cubic metre of air—are measured by a network of air-sampling devices that are stationed at fixed points, chiefly in cities, but the resultant information is spotty and not readily translatable into an average national trend. Water taken from rivers, lakes, underground sources, and wells is also analyzed from time to time for chemical and biological pollutants, but, again, the results are necessarily discrete and localized. Finally, there are less comprehensive measurements that determine the amounts of certain pollutants, such as pesticides, that have been taken up by wildlife, especially fish and birds, and there are also a few corresponding analyses of pollutants carried in the bodies of the human population.

The nation's basic environmental law, the National Environmental Policy Act of 1969, assigns to the federal Council on Environmental Quality the task of reporting these data. Unfortunately, among the first of the Reagan Administration's many cuts in domestic programs was a sixty-two-per-cent reduction in the C.E.Q. budget, which has diminished its reports, especially on water pollution. Nevertheless, by rounding out the C.E.Q. reports with special ones produced by various other government agencies it is possible to piece together a picture of how the environment has fared in the last ten or fifteen years.

VPA 000010475

"Gerald is a man of only one mood."

INFORMATION about the trends in air pollution is available from annual reports published by the Environmental Protection Agency for the years between 1975 and 1985. (Data earlier than 1975 tend to be unreliable, be-

cause measurements were not standardized.) The E.P.A. reports describe changes in the emissions and local concentrations of the major airborne pollutants: particulates (dust), sulfur dioxide, lead, nitrogen oxides, volatile organic compounds, and ozone, a key ingredient of photochemical smog. One striking fact immediately emerges from the monitoring data: it is indeed possible to reduce the level of pollution sharply, for between 1975 and 1985 total annual lead emissions decreased by eighty-six per cent, and airborne concentrations of lead at national test sites have been correspondingly reduced. Lead, a notoriously toxic metal, has been responsible for serious health effects, such as mental retardation, especially among children living in heavily polluted areas. People have benefitted from the reduced emissions: the average lead levels in the blood of Americans decreased by thirty-seven per cent between 1976 and 1980.

The successful effort to reduce lead pollution only accentuates the failure to achieve a comparable reduction in the emissions of the other air pollutants, which, on the average, decreased by only thirteen and two-tenths per cent between 1975 and 1985. Of these pollutants, dust emissions have improved most—about thirty-two per cent—although actual concentrations in the air at some fifteen hundred test sites have improved somewhat less. But the annual improvements came to a halt in 1982, and since then emission levels of particulates have increased; they rose by more than four per cent between 1982 and 1985.

Sulfur dioxide is a particularly serious pollutant, for it diminishes the respiratory system's ability to deal with all other pollutants. It is also a major contributor to acid rain. Between 1975 and 1985, total sulfur-dioxide emissions declined by nineteen per cent, most of the change occurring between 1975 and 1981; since then, emissions have remained essentially constant. Average concentrations at national test sites improved somewhat more, in part because new power plants—a major source of sulfur dioxide—are being built outside urban areas, while most of the test sites are inside urban areas.

Carbon monoxide, a pollutant that causes respiratory problems, is produced chiefly by cars, trucks, and buses, and the effort to deal with it is based on control systems that reduce emissions from automobile exhausts. (The control devices also reduce

waste-fuel emissions.) Total annual carbon-monoxide emissions decreased by fourteen per cent between 1975 and 1985, but between 1982 and 1985 they increased. In a number of cities, including New York, the levels of carbon monoxide still violate E.P.A. standards.

Photochemical smog, a complex mixture, is created when nitrogen oxides emitted from automobile exhausts and power plants are converted by sunlight into highly reactive molecules and these combine with waste fuel to form ozone and other noxious chemicals. The total emissions of nitrogen oxides *increased* by four per cent between 1975 and 1985. Ozone is not emitted as such but is formed in the air during smog reactions. Concentrations at national test sites decreased by fifteen per cent between 1975 and 1981, but have not changed since.

The noxious smog chemicals are responsible for serious health hazards; people with heart or respiratory problems are routinely warned to stay indoors during "smog alerts." This hazard is now more or less accepted as an unavoidable aspect of urban life. In some places, improvements in smog levels have been achieved by reducing traffic; yet smog continues to threaten health. For example, in Los Angeles, the worst-afflicted city, between 1973 and 1977 residents were subjected each year to at least two hundred and fifty days in which smog was at levels classified as "unhealthful," with more than a hundred and twenty-five of these classified as "very unhealthful." In most large American cities, residents are still exposed to unhealthful smog levels for fifty to a hundred and fifty days each year.

One consequence of air pollution is acid rain. In keeping with the ecological rule that everything has to go somewhere, sulfur dioxide and nitrogen oxides, once they have been emitted into the air, are picked up by rain and snow and brought down to earth in the form of sulfates and nitrates. Both these substances increase acidity, and in recent years many lakes—especially in the northeastern United States and Canada, but also in Europe—have become more acid. In some of these lakes, serious biological changes have occurred, often involving the virtual elimination of fish populations. In cities, acid rain erodes buildings and monuments.

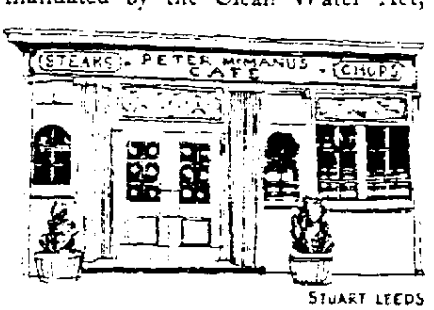
Because scrubbers and the increased use of low-sulfur coal have reduced sulfur-dioxide emissions at coal-burn-

ing power plants, while emissions of nitrogen oxides from power plants and automotive vehicles have increased, there has been a noticeable shift in the relative contributions of these pollutants to acid rain. Reports from Hubbard Brook, a research station in New Hampshire, where acidity problems have been studied for a long time, show that as the sulfate content of precipitation declined by twenty-seven per cent between 1964 and 1981 the nitrate content increased by a hundred and thirty-seven per cent. Not much improvement can be expected in the acid-rain problem, given the negligible improvement in sulfur-dioxide emissions and the rising emissions of nitrogen oxides.

The ecological processes that govern the quality of surface waters are more complex than the chiefly chemical events that govern air pollution. A basic reason for the pollution of surface waters—rivers and lakes—as well as inshore marine waters is the stress placed on the natural ecological cycles that, if they are kept in balance, maintain water quality. If inadequate sewage-treatment systems dump excessive organic matter into a river or a lake, the accompanying fecal bacteria threaten health. As the excess organic matter is broken down by aquatic microorganisms, they may consume so much oxygen that fish begin to die. If urban and industrial waste and runoff from agricultural areas increase nitrate and phosphate concentrations beyond the levels maintained by a balanced cycle, eutrophication occurs. Heavy algal blooms are formed and soon die, burdening the system with excessive organic matter and reducing oxygen content. In addition, high nitrate levels in drinking water may create health problems such as methemoglobinemia (a condition that reduces the oxygen-carrying capacity of the blood, especially in infants) and may contribute to the formation of carcinogens. Toxic chemicals only add to these harmful effects.

In the last decade, particular rivers and lakes here and there have been cleaned up by closing sources of pollution and building new sewage-treatment plants. Yet in that period, nationally, there has been little or no over-all improvement in the levels of the five standard pollutants that determine water quality: fecal coliform bacteria, dissolved oxygen, nitrate, phosphorus, and suspended sediments. A recent survey of the trends in pollution levels between 1974 and 1981 at nearly four hundred locations on major American rivers shows that there has been no improvement in water quality at more than four-fifths of the tested sites. For example, the levels of fecal coliform bacteria decreased at only fifteen per cent of the river stations, and increased at five per cent. At half the locations, the bacterial count was too high to permit swimming, according to the standard recommended by the National Technical Advisory Committee on Water Quality Criteria. Levels of dissolved oxygen, suspended sediments, and phosphorus improved at thirteen to seventeen per cent of the locations, but deteriorated at eleven to sixteen per cent of them. The most striking change—for the worse—was in nitrate levels: increases were observed at thirty per cent of the test stations and decreases at only seven per cent. Agricultural use of nitrogen fertilizer is a main source of this pollutant; in rivers that drain cropland, the number of sampling stations that report rising nitrate levels is eight times the number reporting falling levels. Another major source is nitrogen oxides emitted into the air by vehicles and power plants and deposited in rain and snow as nitrate; this accounts for increased river nitrate levels in the Northeast, despite the relative scarcity of heavily fertilized acreage in that area. The survey also shows that there was a sharp increase in the occurrence of two toxic elements, arsenic and cadmium (a cause of lung and kidney damage), in American rivers between 1974 and 1981; but, as expected from the reduced automotive emissions, the occurrence of lead declined.

An over-all assessment of the changes in these standard measures of water quality can be gained from the average trends. For the five standard pollutants, the frequency of improving trends averaged 13.2 per cent; but the frequency of deteriorating trends averaged 14.7 per cent; thus, at more than four-fifths of the test sites, over-all water quality deteriorated or remained the same. In sum, the regulations mandated by the Clean Water Act, and more than a hundred billion dollars spent to meet them, have failed to improve water quality in most rivers. The relatively few locations that have improved are more than cancelled out by the locations that have deteriorated. Moreover, the occurrence of three serious pollutants—nitrate, arsenic, and cadmium—has increased considerably.



STUART LEEDS

One of the chief symptoms of the environmental crisis in the early nineteen-seventies was eutrophication, especially in lakes. Lake Erie provided a dramatic example. The lake received an enormous burden of inadequately treated sewage and phosphate-rich detergents from the cities surrounding it, and chemical plants contributed mercury and other toxic materials as well. Rivers carried nitrate and eroded soil into the lake from heavily fertilized farms. By the nineteen-sixties and seventies, especially in its western regions and along the shoreline, Lake Erie was exhibiting the classic signs of eutrophication: heavy algal overgrowths, epidemics of asphyxiated fish, and sharply declining fish catches. Because of its notoriety as a "dying lake," Lake Erie has been intensively studied in the last decade, and the results have been evaluated by elaborate statistical techniques; the most detailed data are given in a recent lengthy E.P.A. report. This report makes a telling comparison of pollution levels along various reaches of the western lakeshore, where eutrophication had been particularly troublesome. In 1972 and 1973, three of twenty-one shoreline regions were classified as entirely or partly eutrophic; in 1978 and 1979, eutrophication was more widespread, affecting twelve of twenty-one shoreline regions.

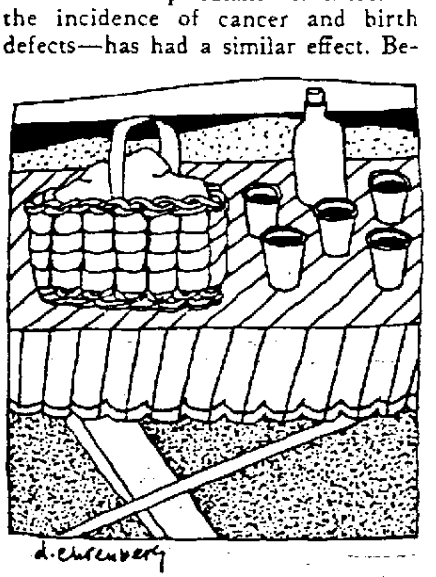
According to the E.P.A. report, the rate of oxygen depletion in the central basin of Lake Erie increased by fifteen per cent between 1970 and 1980, following a trend that went back as far as 1930. The entry of phosphates from certain city sewage systems has declined, as a result of campaigns to reduce the use of phosphate-containing detergents—probably the most successful such effort, in Detroit, reduced phosphate concentrations in the Detroit River by nearly seventy per cent between 1971 and 1981—but the acquisition of phosphates from all the rivers entering the lake was reduced much less; only four of twelve test sites showed any improvement. Over all, phosphates entering Lake Erie decreased by about a third between 1972 and 1982. The same E.P.A. report

also records the catch of commercial fish from 1920 to 1980. The once valuable catch of herring and whitefish dropped off sharply after 1950, and by 1960 it was close to zero. The E.P.A. report showed that the catch had not recovered between 1960 and 1980.

In 1970, Lake Erie was widely mourned as a dying lake, and serious efforts were made to revive it. Yet nearly two decades after our environmental reawakening Lake Erie, despite some limited improvements, remains a flagrant example of environmental pollution. The condition of less famous lakes is just as bad. This is particularly true of lakes in heavily farmed areas, where nitrogen and phosphorus fertilizers leach from the soil into rivers and lakes. A 1982 survey found that of a hundred and seven lakes in Iowa all were eutrophic, and so were more than eighty per cent of the lakes in Ohio and Pennsylvania. A national survey of changes in water quality between 1972 and 1982 showed almost no progress in lakes. Only 2.4 per cent of the total lake acreage improved; 10.1 per cent became more degraded; 62.1 per cent was unchanged; no reports were available for the remainder.

About fifty per cent of the population of the United States depends on underground sources—groundwater—for its drinking water. The United States Geological Survey and state agencies monitor the quality of groundwater by testing wells throughout the country. The results, based on readings from more than a hundred thousand wells, show that in the past twenty-five years these sources have become increasingly polluted by nitrates and toxic chemicals. Fertilizer was chiefly responsible for the rising nitrate levels. In Nebraska, a 1983 survey showed that eighty-two per cent of the wells over the nitrate limit established by health authorities (ten milligrams per litre of nitrogen in the form of nitrate) were contaminated by fertilizer nitrogen. In California's Sacramento Valley, a very heavily cropped area, nitrate contamination of wells has been monitored for a long time. In the fifty-year period following 1912, the percentage of wells with excessive nitrates (defined as five and a half milligrams per litre) approximately doubled. More recently, the percentage of wells with excessive nitrates doubled again—this time in only a four-year period, between 1974 and 1978. The major source of the nitrates is nitrogen fertilizer leaching from irrigation water. A similar trend has been observed in Iowa. In 1984, the Geological Survey summarized the situation: "Current trends suggest that nitrate accumulations in groundwater of the United States will continue to increase in the future."

FIFTEEN years ago, public-opinion polls on environmental issues showed that most people were worried about water and air pollution—especially smog. Now, even though these problems remain largely unsolved, polls show that as a public concern air and water pollution runs behind a new environmental threat—toxic chemicals. In the early nineteen-seventies, this problem was due largely to agricultural products—insecticides, herbicides, and fungicides. DDT and similar chlorinated insecticides were the most notorious examples. In 1972, the use of DDT and related insecticides was banned in the United States because they were shown to promote cancers and also to be a hazard to wildlife. One of the most noticeable effects of DDT was the decline in bird populations; DDT interferes with the biochemistry of reproduction, making eggs thin-shelled and thus easily destroyed before they hatch. Banning the use of DDT has been very effective. For example, between 1969 and 1975 the average DDT content of brown pelicans in South Carolina decreased by seventy-seven per cent, and by 1976 the number of fledglings more than tripled. People have benefitted as well: between 1970 and 1983, average DDT levels in body fat in the American population decreased by seventy-nine per cent. The banning of polychlorinated biphenyl, another notorious chemical pollutant—it increases the incidence of cancer and birth defects—has had a similar effect. Between 1970 and 1980, the body burden of PCB in freshwater fish decreased by fifty-six per cent, and in birds (starlings) by eighty-six per cent. In people, the percentage of Americans with relatively high levels of PCB (above three parts per million) in their fatty tissue decreased by about seventy-five per cent.



Since 1950, however, the roster of serious chemical pollutants has steadily expanded. Hundreds of toxic chemicals, many of them carcinogenic, have been detected in water supplies, air, and food. For the first time in the three-and-a-half-billion-year history of life on this planet, living things are burdened with a host of man-made poisonous substances. According to a recent E.P.A. survey, members of the general American population now carry several dozen man-made chemicals, many of them carcinogenic, in their body fat (and generally in the fat of mothers' milk as well). Toxic chemicals now seriously pollute important segments of the food chain. In the Great Lakes, for example, the toxic-chemical levels of salmon, trout, and walleye often exceed Food and Drug Administration standards for human consumption. Tumors are found on the fish with increasing frequency.

The total toxic-chemical problem is huge. The American petrochemical industry produces about two hundred and sixty-five million metric tons of hazardous waste annually; toxic chemicals generally make up about one per cent of this material, and the rest is made up of water and other non-toxic carriers. About a third of this waste is emitted, uncontrolled, into the environment. Moreover, most of the controlled, or "managed," waste is injected underground, sometimes into water systems, and thus becomes a long-term threat to the environment. Only about one per cent of the industry's toxic waste is actually destroyed. The chemical industry has, largely unrestrained, become the major threat to environmental quality.

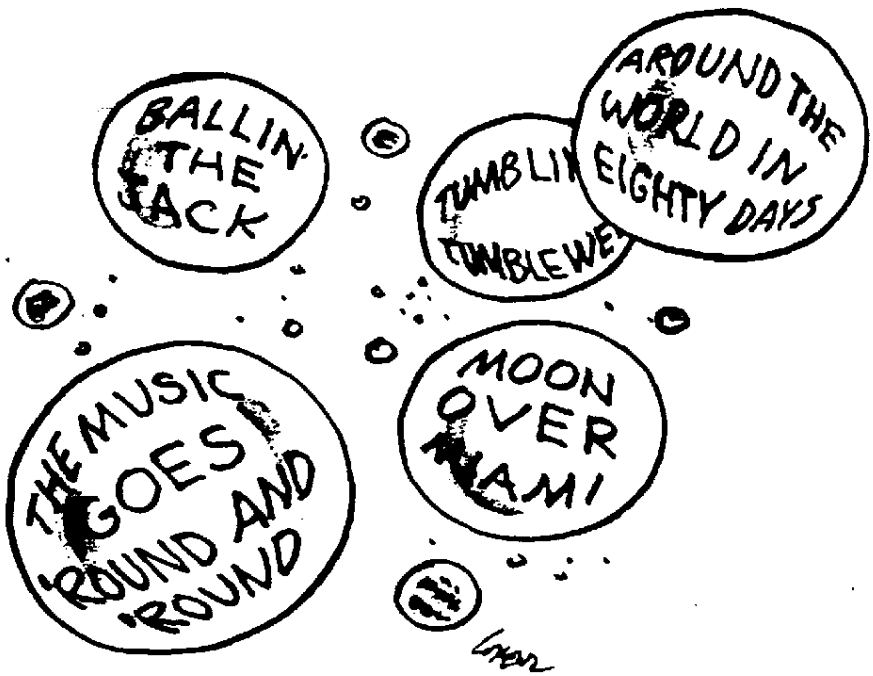
ENVIRONMENTAL pollution from radioactive materials is in a class by itself; it originates from a single sector of production—the manipulation of nuclear energy for peaceful or military purposes. Radiation exposure due to the normal operation of the nuclear power industry appears to be quite small compared with exposure to natural sources of radioactivity such as radon and cosmic rays; it is less than one one-hundredth of one per cent of the

natural exposure. But this is a national average; near power plants, exposures are certainly higher.

There is no widely disseminated accounting of the radioactivity that enters the environment from minor nuclear-power-plant malfunctions. At most, there are only reports that an accidental emission of radioactive material has occurred—generally with no information about the actual radiation exposure but only the statement that "the amount of radiation released was harmless." (Such statements are wrong. Radiation, no matter how weak, always involves the risk of some harm, and the risk is proportional to the dose received. A very small exposure from a dental X-ray, say, has a correspondingly small risk, which is presumably worth taking in view of the expected benefit.) A partial measure of the radioactivity released by nuclear power plants is available from E.P.A. studies of krypton-85, a radioactive gas uniquely associated with the operation of such plants. The average annual concentration of krypton-85 in the air increased by eighty per cent between 1970 and 1983, thus increasing the environmental hazard.

Accidents that disrupt the containment structures protecting the environment from the huge amount of radioactive material in an operating nuclear reactor present a far larger hazard than is presented by typical malfunctions. Until 1979, this was an abstract concern, for some abstruse—and considerably disputed—statistical computations concluded that the probability of a serious accident might be as low as one in a million per year per reactor. The accident at the Three Mile Island nuclear power plant, in 1979, brought the abstract discussions down to earth. While the outcome of the accident was far less serious than it might have been—the reactor's core partially melted and extensively contaminated the interior of the reactor building and released some radioactivity into the environment—it suggested that serious mechanical failures were far more probable than the calculations had indicated.

In April of 1986, of course, a second failure occurred—at the Soviet Union's Chernobyl nuclear power plant—which led to a radioactive disaster. At least thirty-one people have died and more than two hundred have suffered acute radiation sickness; estimates of future cancer deaths from the radioactive fallout over a wide area of Europe range above a hundred thousand; more than a hundred thousand people have been evacuated from their homes; some hundreds of square miles of agricultural land have become useless; radioactive fallout disrupted milk and vegetable production throughout most of Europe.



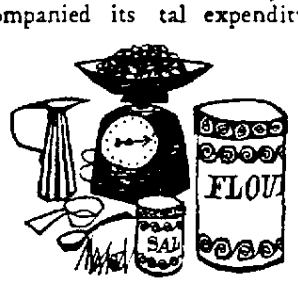
The hazardous consequence of one aspect of nuclear technology—fallout from test explosions of nuclear weapons in the atmosphere—has been considerably reduced by the straightforward procedure of simply stopping the process that creates it. As a result of the 1963 treaty signed by the United States and the Soviet Union, atmospheric tests have halted (except for a few conducted by China and France), and fallout radioactivity, in keeping with natural decay processes, has declined. For example, a national survey of milk showed that it contained 23.8 picocuries of strontium 90 per litre in 1964, 7.3 in 1970, and 2.0 in 1984.

FINALLY, we need to consider the American contribution to global environmental problems. One of these problems is the progressive depletion of ozone in the stratosphere, which is due largely to the increased use of chlorofluorocarbons (petrochemical products widely used in refrigerators and air-conditioners). The stratospheric ozone layer protects the earth from solar ultraviolet radiation; if it is sufficiently depleted, people will be exposed to an intensity of radiation capable of significantly increasing the incidence of skin cancer. Recent studies in Antarctica indicate that the ozone layer is continuing to thin out. Despite an international agreement to reduce the production of chlorofluorocarbons, and some progress in the United States, little has been done thus far to stop this chemical assault on the stratosphere. Another problem is the progressive warming of the earth's surface because of the accumulation of carbon dioxide and other gases in the upper atmosphere. Sunlight falling on the earth is sooner or later converted into heat, which radiates outward, so the planet's temperature is determined by the balance between the sunlight falling on the earth and the heat leaving it. The concentration of carbon dioxide in the atmosphere governs the re-radiation process, for the gas acts like an energy valve, allowing sunlight through but tending to hold heat back. Since 1850, the increased use of

fuel that produces carbon dioxide when it is burned has gradually increased the atmospheric-carbon-dioxide concentration, and the earth's average temperature has steadily risen; an additional three or four degrees Fahrenheit in average temperature is expected by the middle of the twenty-first century. This may cause drastic changes in climate—for example, flooding of coastal areas (including many cities), and severe drought in North America, Europe, and Asia. In recent years, other gases, such as the chlorofluorocarbons, have added to the problem. As a result, the latest projections predict severe climatic changes by 2030.

This "greenhouse effect" (glass resembles carbon dioxide in its effect on sunlight and heat, a property that helps to keep a greenhouse warm in the winter) can be slowed down only if there is a sharp reduction in the use of combustible fuel, but nothing has been done thus far to deal with this problem, and it continues to carry the world toward a climatic catastrophe.

SO much for the statistics on the changing state of the environment. What do they mean? Do they indicate that we can repel the assault on the environment by gradually reducing pollution at the present modest and uncertain rate? Can we accelerate the process by more stringent emission controls? Each year, the annual C.E.Q. report has accompanied its environmental statistics with optimistic answers to such questions. The 1983 report, for example, began the chapter on environmental trends with this assertion: "As measured by traditional indices, such as the amount of pollutants in surface water and air, the overall quality of the environment in the United States seems to be improving." This modest claim was inflated by President Reagan, who said shortly after the report appeared, "I am proud to report that the most recent studies of the Environmental Protection Agency show that we have made great progress in cleaning up the air and water"—a statement, hardly warranted by the facts, that one environmental leader described as "a big leap forward," because Reagan chose even to mention the environment.



Self-praise is perhaps natural from the President and the government agency that is responsible for improving the environment, but it is scarcely justified by the Administration's enforcement record. From 1973 to 1979, the annual number of civil enforcement actions by the E.P.A. increased year by year, paralleling the modest decline in pollution levels, at least in the air. Then, after Reagan took office, budget cuts were imposed on the E.P.A. most severely in those divisions which deal with enforcement. To no one's surprise, enforcement proceedings dropped off; between 1980 and 1981, the number of cases involving violations of environmental laws that the E.P.A. referred to the Department of Justice decreased by sixty-nine per cent. More recently, with new E.P.A. administrators, the caseload has increased, suggesting that the earlier decrease reflected Administration policy rather than some sudden decline in the number of environmental scofflaws.

These changes can be directly traced to policies established by President Reagan, who in transmitting a recent annual environmental report to Congress declared, "We have expanded innovative programs which allow industry the regulatory flexibility and economic incentives to clean up pollution." The term "regulatory flexibility" is the industrial lobbyist's well-known euphemism for relaxing the enforcement of regulations. And Reagan's message has obviously been received by American industry. Capital expenditures for new plant and equipment for pollution abatement by American industries, which had been at an average level of about four billion eight hundred million dollars per year (in constant 1972 dollars) between 1973 and 1980, have since declined, sinking to three billion dollars in 1983. It is, of course, not surprising that Reagan's policies have been carried out by his environmental agencies and his industrial supporters. What was also foreseeable, and even more disturbing, was that these policies would affect the environment itself. So while the annual emissions of air pollutants gradually declined between 1975 and 1981, the year in which Reagan took office, they have since decreased much more slowly or not at all. For all the air pollutants other than lead, the average annual rate of decline in emissions was 1.52 per cent between 1975 and 1981 but only 1.16 per cent between 1981 and 1985. Indeed, since 1982 the long-term, if gradual, decline in air-pollutant emissions has come to a halt. Between 1982 and 1985, there was an average annual *increase* of 0.87 per cent in these emissions; the emission of only one of the five pollutants (sulfur dioxide) declined. It has been argued that the halt in the rate of environmental improvement is due not so much to weaker enforcement and reduced abatement expenditures as to increased industrial activity during the period. However, industrial activity between 1975 and 1980 increased at about the same rate as it did between 1982 and 1985, but it was only in the earlier period that the major decline in air-pollution levels occurred. It appears that Reagan has left his mark not only on environmental policy but also on the environment itself—a mark that can be measured in tons of dust, sulfur dioxide, carbon monoxide, nitrogen oxides, and organic compounds that could otherwise have been removed from the nation's polluted air.

The lack of improvement in the acid-rain problem can also be traced to Reagan's policies. While his Administration has grudgingly acknowledged that there is an acid-rain problem, it has refused to accept the widely held view of its cause, and has therefore done little to deal with it apart from a recent Administration promise to fund more research—an action that led a member of the Canadian Parliament to remark, "It won't reduce emissions by a single ounce."

Though environmental organizations are usually critical of Reagan's environmental stewardship, they nearly match his optimism about the course of environmental improvement. For example, the Conservation Foundation's 1982 report entitled "State of the Environment" claimed:

> The nation has made impressive progress in its attack on some conventional environmental problems. . . . Emissions of most major air pollutants have continued to decline. . . . Available data show no similar progress toward water quality goals. Still, even to hold the *status quo* is an achievement in the face of significant economic and population growth since 1970.

It seems that at least some environmental activists are moderately happy about their accomplishments. But such optimism does not necessarily respond to the original thrust of the environmental movement, which envisioned

not an environment that was a little less polluted than it was in 1970, or holding its own against an expanding economy, but an environment free of mindless assaults on ecological processes. By this standard, the question is whether the movement's goal can be reached by the present spotty, gradual, and now diminishing course of environmental improvement or whether some different course must be followed. To find the answer, it is helpful to distinguish between the reasons for the rather few environmental successes and the reasons for the more numerous partial or complete failures. We need to explain the striking fact that while the levels of most pollutants have declined only modestly, and others not at all, a few have been reduced quite sharply: lead, DDT and similar chlorinated pesticides, mercury in surface waters, radioactive fallout from nuclear-bomb tests, and, in some rivers, phosphates. Understanding these successes, which begin to fulfill the original aim of the environmental movement, may shed light on the reasons for the more common failures and suggest how they may be remedied. There are two general ways in which a pollutant may be prevented from entering the environment: either the pollutant is eliminated from the activity that generates it, or a control device is added to trap or destroy the pollutant before it enters the environment.

The few real improvements have been achieved not by adding control devices or concealing pollutants (as by pumping hazardous chemical wastes into deep water-bearing strata) but simply by eliminating the pollutants. For example, the reason that there is now so much less strontium 90 in milk and in children's bones is that we and the Russians have had the simple wisdom to stop atmospheric testing of nuclear weapons, which produces it.

When the process that produces a pollutant is stopped—the banning of pesticides, the halt in atmospheric nuclear testing—there is considerable environmental improvement; if, instead, an effort is made to control the pollutant by recapturing or destroying it before it escapes into the environment, there is some improvement in environmental quality, but generally not much. In fact, such controls are ultimately self-defeating. To begin with, the effect of a control device is never complete. For example, unlike the absolute impact on lead pollution of the phasing out of leaded gasoline —after all, every ounce of lead not added to gasoline is also absent from the environment—the installation of an exhaust-control system cannot completely halt carbon-monoxide pollution. Even when the system is in perfect working order, it does not trap all the carbon monoxide but only about ninety per cent of it. Besides, the effectiveness of the catalyst rapidly declines with use, so any delay in replacing it means increased pollution. As long as control devices are not absolutely perfect—and none are—continued increase in the pollution-generating activity (traffic, for example) will gradually overwhelm the devices' effect on environmental quality. Finally, control devices cannot be used at all if the pollutant's points of entry into the environment are so numerous that they are impossible to identify. The classic example is the nitrates that leach from heavily fertilized soil into rivers and lakes along every inch of their banks.

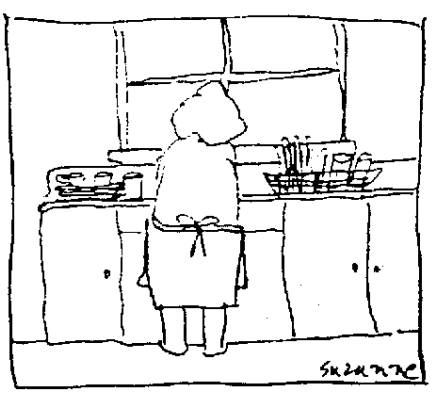
All these reasons explain why those environmental pollutants—concentrations of carbon monoxide, sulfur dioxide, and dust, for example—that are now subjected to control systems have decreased so slowly. They also explain

why pollution from agricultural chemicals such as nitrogen fertilizer, which arises from "non-point" sources, has continued to increase.

Thus, the decade or more of effort to improve the quality of the environment teaches us a fairly simple lesson: pollution levels can be reduced enough to at least approach the goal of elimination only if the production or the use of the offending substances is halted. This precept directs our attention to the technology of production—the vast and varied machinery of industry, agriculture, and transportation. We can then see that all the really successful environmental improvements have been achieved by altering that technology. The very considerable reduction in mercury in Lake Erie nicely illustrates this fact. In 1970, there were very high concentrations of mercury in Lake Erie sediments; most of the lake bottom contained a thousand to two thousand parts per million, and more than that near the outlet of the Detroit River. In March of 1970, walleye contaminated with seven parts per million—fourteen times the acceptable level—were found in a tributary of the lake. The major source was soon discovered: chlorine-producing plants that used mercury to conduct the electric current that, passed through a brine solution, yielded the chlorine. Threatened by legal action, the plants adopted an alternate technology in which a semi-porous diaphragm instead of mercury established the electrical circuit. By 1979, the concentration of mercury in most of the lake sediments was less than three hundred parts per million, and fish levels were much improved. Mercury pollution in Lake Erie was sharply curtailed by the simple process of changing the technology of chlorine production.

PCB provides a similar example. This highly toxic synthetic substance was widely used in a number of processes, ranging from the manufacture of "carbonless" carbon paper to the manufacture of electrical transformers. When PCB production was banned, in the late nineteen-seventies, each of these manufacturing processes was simply altered to exclude it, and emissions into the environment fell precipitously. In the same way, the levels of DDT and related insecticides in the environment and in the human body have declined considerably because those substances were eliminated from agricultural practice in the early nineteen-seventies. In this case, the altered technology only replaced one hazard with another. Toxaphene, a hazardous insecticide, was widely used instead of DDT, especially for cotton crops; as a result, while their DDT content fell the toxaphene content of fish increased more than twentyfold between 1970 and 1980.

In sum, there is a consistent explanation for the few instances of environmental success: they occur only when the relevant technologies of production are changed to eliminate the pollutant. If no such change is made, pollution continues unabated or, at best—if a control device is used—is only slightly reduced. For example, pollution from fertilizer nitrates, which cannot be controlled, has increased because nitrogen fertilizer, far from being banned, continues to play a major role in agricultural production. In the same way, adding a control device to the automobile engine without changing its basic technology has only slightly reduced carbon-monoxide pollution. What has been done in regard to automotive technology accounts for both a striking environmental success, the eighty-six-per-cent reduction in environmental lead, and a very troublesome failure, the continued emissions of nitrogen oxide, contributing to the attendant smog and acid rain. As we have seen, lead pollution was reduced by the simple expedient of cutting back its use in gasoline. This change was motivated partly by concern over the health hazard but perhaps more strongly by a technological accident: the platinum catalyst in the exhaust system designed to control carbon monoxide is poisoned by lead. But when the E.P.A. was forced to mandate a shift from leaded to unleaded gasoline the lead had to be replaced, not merely eliminated, for it performed an essential function in current gasoline engines. It prevented the "knocking" that can seriously hamper the operation of modern, high-compression engines. Today, oil companies have replaced lead with petrochemical anti-knock compounds (which they produce) or, to a much smaller extent, with ethanol produced from agricultural crops.



Removing lead from gasoline unequivocally eliminated its impact on the environment, but the nitrogen-oxide problem is much more intractable. Unlike lead, which had been deliberately introduced into the gasoline engine, nitrogen oxides are an unwanted by-product of its operation. Modern engines produce nitrogen oxides because they run at higher compression ratios, and therefore at higher temperatures, than older engines. At such elevated temperatures, when the oxygen and nitrogen in the air are drawn into the engine they react chemically, forming nitrogen oxides. After the Second World War, because American car manufacturers decided to build larger cars they were forced to install more powerful engines. In turn, more power required a higher compression ratio, and, inevitably, nitrogen oxides were emitted. Thus, the auto industry's decision to build larger cars created the photochemical-smog problem and worsened the problem of acid rain.

Apart from a limited flirtation with small cars during recent energy shortages, the industry has been unwilling to build cars light enough to be driven by low-compression engines. An existing engine that can operate at high compression ratios without subjecting the air in the cylinder to excessive temperatures (the "charge-stratification" engine) could also help to solve the problem. But American manufacturers have thus far been reluctant to make the large-scale production changes needed to take advantage of this opportunity. Nitrogen oxides from automotive transportation could also be eliminated by the substitution of electric motors, which produce no environmental emissions at all, for the present ones. In diesel engines, diesel-fuel combustion produces carcinogenic chemicals, and these adhere to the tiny carbon particles emitted by the engine. Here, too, the auto industry has been unwilling to make the considerable changes in engine technology needed to reduce the hazardous emissions. Smog and diesel carcinogens continue to burden the air—and our bodies—because the productive technologies that generate them have not been changed to eliminate them.

In essence, the effort to deal with

environmental pollution has been trivialized. A great deal of attention has been paid to designing—and enforcing the use of—control devices that can reduce hazardous emissions only moderately. Much less attention has been given to the more difficult but rewarding task of changing the basic technologies that produce the pollutants.

Production technology encompasses not only the design of a particular facility, such as a car, but the over-all system in which it operates—in this case, transportation. While remedying the vehicle's inherent faults is useful, much greater environmental improvement can be accomplished by addressing the system of transportation as a whole. Compared with railroads, cars are a highly inefficient means of long-distance and commuter travel, but they are essential in many places, even with effective mass transit, for urban travel. Cars designed exclusively for this purpose could be much lighter and driven by less powerful low-compression engines or, for that matter, by non-polluting electric motors. Together with the expansion of urban and suburban mass-transit systems and inter-urban rail lines, this would virtually eliminate ozone and smog and greatly reduce environmental nitrogen oxides. Moreover, lower gasoline consumption would reduce carbon-monoxide emissions even without exhaust controls. In the same way, carcinogenic diesel exhaust could be sharply reduced by a shift from truck-borne freight to railroad freight, which is four times as fuel-efficient. In sum, the serious continuing impact of the transportation system on the environment results from the failure to alter not only the technical design of cars, trucks, and buses but also the system of transportation itself.

The effort to deal effectively with sulfur-dioxide and dust pollution from power plants has been hampered by the same sort of superficial approach—reliance on control devices rather than changes in production technology. Since the early nineteen-seventies, more stringent requirements for control systems have apparently reduced the contribution of coal-burning power plants to sulfur-dioxide and dust emissions. But changes in the over-all structure of the power system have had the opposite effect. In recent years, coal has progressively displaced oil and natural gas as a power-plant fuel, and since these fuels produce far less sulfur dioxide and dust than coal does this shift has added to the sulfur-dioxide problem. But no serious effort has been made to promote existing sources of power that can improve environmental quality. These include solar sources, such as photovoltaic cells, and decentralized power systems—notably cogenerators—that greatly enhance fuel efficiency, so that their environmental impact is much less than that of conventional power plants. Under the Reagan Administration, government support for the development of such energy sources has been severely reduced.

In the petrochemical industry, which generates the toxic chemicals that so grievously pollute the environment, there is a unique relationship between environmental impact and the technology of production. In other sectors of production—the electric-power industry, say—the product is not itself a pollutant, and there are environmentally benign ways of producing it. In contrast, the manufacture of almost every petrochemical product is accompanied by the production of toxic wastes. Moreover, many of the goods manufactured, such as pesticides and plastics, are pollutants themselves. In effect, environmental pollution is an integral aspect of petrochemical-production technology.

The chemical disaster in Bhopal, India, in 1984, in which thousands of people died and two hundred thousand were injured, many of them for life, dramatizes the problems inherent in petrochemical-production technology. The conventional view is that the Bhopal disaster was due to some technical fault in the plant that produced the toxic chemical methyl isocyanate, which is used to manufacture insecticides. There is, of course, no perfectly accident-free industrial process; and this is particularly true of petrochemical plants, which not only are complex but turn out numerous dangerous products and by-products. Indeed, there have been repeated accidents at the Union Carbide methyl-isocyanate plants both in Bhopal and in Institute, West Virginia—accidents that have exposed workers and in some cases the neighborhood to this dangerous substance. The conventional view accepts the inevitability of such risks and seeks to balance them against the benefits of producing methyl isocyanate. For example, a *Time* cover story on the Bhopal disaster stated:

> The citizens of Bhopal lived near the Union Carbide plant because they sought to live there. The plant provided jobs, the pesticide more food. Bhopal was a modern parable of the risks and rewards originally engendered by the Industrial Revolution. . . . The world is Bhopal, a place where the occupational hazard is modern life. History teaches that there is no avoiding that hazard, and no point in trying; one only trusts that the gods in the machines will give a good deal more than they take away.

This is a widely held position: the chemical plant improved the life of the Indian people; such disasters seem to be a price that must be paid for such benefits of modern production technology. But the facts contradict this position. Consider how well the Bhopal plant "provided jobs." Bhopal is a city of six hundred and seventy thousand people, and perhaps a third of them were living in shanties next to the plant. But the plant provided jobs for only a few hundred. The community that grew up around the plant had been attracted not by jobs but by secondary amenities like the water supply and the roads, and the vast majority of the people lived in extreme poverty.

And how well do the pesticides that are produced from methyl isocyanate —carbamate insecticides such as Sevin and Temik—provide more food? Such pesticides can, of course, protect crops from insect attack and improve production. However, in developing countries most pesticides are used not on local food crops but on crops grown for export—cotton, coffee, bananas. Such "monoculture" agriculture is particularly susceptible to insect attack, so there is a heavy reliance on pesticides. For example, a 1979 study reported that El Salvador, a very small country, used about one-fifth of the world's parathion output to treat its coffee crop. Moreover, Third World countries use many hazardous pesticides that have been banned in the developed countries. Although relatively little pesticide is used directly on food crops, they are nevertheless contaminated by pesticides sprayed on nearby export crops. As a result, food grown in Third World countries is often heavily contaminated. Yet crops can be produced with much less dependence on pesticides. "Integrated pest management" is a way of deciding at precisely what time and in precisely what amounts an insecticide is needed. It can considerably reduce the amounts used, and therefore the danger of con-

tamination. Because of opposition from the chemical companies, however, this process is still little used in the United States or in other developed countries, and is used hardly at all in developing countries.

The real goal at Bhopal, therefore, should be not merely to make the plant safer but to end the need for operating it by transforming the technology of agricultural production: eliminating—or, at least, greatly reducing—its dependence on pesticides. Rather than trust in the gods in the machines, we need to decide for ourselves what kinds of machines best serve both the environment and society.

Unlike the steel, auto, and electric-power industries, the petrochemical industry—on its present scale, at least—is not essential. Nearly all its products are substitutes for perfectly serviceable preëxisting ones: plastics for paper, wood, and metals; detergents for soap; nitrogen fertilizer for soil, organic matter, and nitrogen-fixing crops (the natural sources of nitrogen); pesticides for the insects' natural predators. Apart from relatively few items that cannot be produced in any other way—such as pharmaceutical drugs, videotape, and the plastic artificial heart—petrochemical products could be replaced by less hazardous ones. Thus, the petrochemical industry is unique: not only its wastes but its very products degrade the environment; its hazards are largely immune to either prevention or control; and most of its products are replaceable. The petrochemical industry is inherently inimical to environmental quality. The only effective way to limit its dangerous impact on the environment is to limit the industry itself.

TO ardent environmentalists, such talk about the technology of production may seem an irrelevant, or even a hostile, digression. Like any embattled minority, environmentalists are prone to emphasize the singular importance of their special interest—the preservation of the natural environment. This position, of course, has a good deal of merit; after all, every aspect of human society depends on the ecosystem—for the natural resources that support production, for the air we breathe, for the green plants that feed us and other animals. Moreover, the environment is governed by stubborn, largely unalterable natural forces, while the system of production is subject to human choice. Logically, therefore, the decisions that determine the choice of production technology ought to be governed by the constraints inherent in nature. But in fact the actual direction of governance is reversed. The design of the man-made system of production is not governed by the nicely balanced attributes of the natural system; instead, as we have seen, the state of the environment is determined by the production technologies that have been chosen to support industry, agriculture, and transportation.

So the environmentalist who wishes to grapple with this illogical arrangement needs to turn from the fairly rigid but harmonious pattern of nature to the more flexible but chaotic realm of human decisions. And this realm necessarily includes not only the choice of production technologies but also the closely related economic decisions. Logic tells us that the economic system—the processes that mediate the flow of wealth—is contingent on the system of production, which is, after all, the source of the goods and services that generate economic wealth. In a logical arrangement, therefore, just as environmental constraints

ought to govern the design of the production system, that design should, in turn, specify appropriate features of the economic system. For example, if the importance of eliminating smog ought to specify the design of automobile engines, then the need to build such engines ought to govern the automobile industry's investment decisions—in part, at least. But here, too, the logical direction of governance is reversed: the decisions that determine the design of the system of production —what is produced and by what technological means—are determined largely by economic considerations that are quite independent of the product's environmental impact, the chief consideration being the profitability of the enterprise.

In sum, the decisions that govern environmental quality originate in the economic realm, and are translated into the design of productive technology, which—as now constituted—in turn visits upon the environment the evils of pollution. This relationship becomes clear when we consider the origins of the major environmental problems. Smog, for example, is the end result of the economic motivation that led the auto industry to decide to manufacture large, powerful cars, for, as John DeLorean, a former General Motors executive, has said, "when we should have been planning switches to smaller, more fuel-efficient, lighter cars in the late 1960s in response to a growing demand in the marketplace, G.M. management refused because 'we make more money on big cars.' "

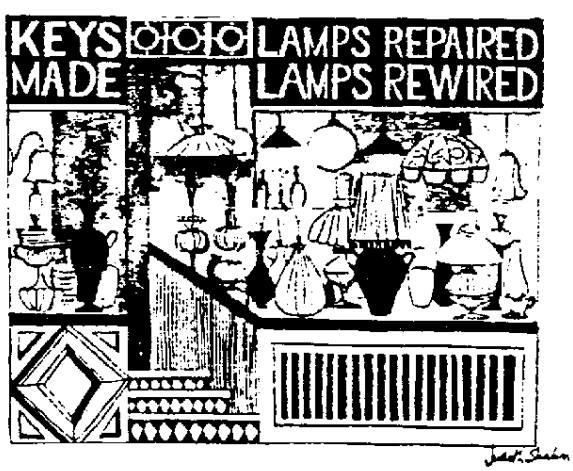
Recent changes in the technology of electric-power production which have seriously affected environmental quality have also been economically motivated. When the utilities were persuaded that nuclear power would be "too cheap to meter," they hastened to build nuclear power plants, thereby creating the monumental hazards of nuclear accidents and the still unresolved problem of radioactive waste. Then, when this hope turned into an illusion, there was a rapid switch to coal-fired plants, because they produce cheaper electricity than oil-powered or nuclear-powered plants—but they also produce much more sulfur dioxide. In the same way, the steel industry's response to the demand for plants that would be less polluting—closing rather than improving them—is motivated by the higher profits obtainable from alternative investments in oil and chemicals. Similarly, the postwar history of American agricultural chemicals was motivated by the increased economic returns on investment that they engendered. Finally, the production of petrochemicals is more profitable than the manufacture of the products that they replace; for example, profits on detergent production are significantly higher than profits on soap production.

It is economic motivation, then, that has impelled the sweeping anti-ecological changes in the technology of production that have occurred since the Second World War. These changes have turned the nation's factories, farms, vehicles, and shops into seedbeds of pollution: nitrates from fertilizer; phosphates from detergents; toxic residues from pesticides; smog and carcinogenic exhaust from vehicles; the growing list of toxic chemicals and the mounds of undegradable plastic containers, wrappings, and gewgaws from the petrochemical industry.

The decisions to make these technological changes have been shortsighted not only because of their impact on the environment but also because they often generate serious economic problems. For example, the intensive use of agricultural chemicals has harmed not only the environment but, in recent years, the agricultural economy as well. As increasing amounts of fertilizer are applied to the soil, crop growth reaches a limit, and thereafter the yield produced per unit of fertilizer falls, and economic productivity is reduced. At the same time, excess, unassimilated fertilizer leaches through the soil into surface water and intensifies pollution. Similarly, the continued use of pesticides breeds resistance in the pests, so that more and more of the chemicals must be used to achieve the same effect. For these reasons, the economic productivity of agricultural chemicals—that is, the crop output per unit of chemical input—has decreased by fifty per cent since 1960, and it is still falling. Thus, both increased stress on the environment and falling economic efficiency are inherent in the present system of agricultural production. In the past few years, American farming has been undergoing a deepening economic crisis, marked by numerous bankruptcies, especially of family farms. Each year, as agricultural chemicals become more expensive and less efficient in improving crop production, farmers must incur a higher debt to buy the chemicals, and thereby become more vulnerable to bankruptcy. The heavy dependence of agricultural technology on chemicals has hurt not only the quality of the environment but the farmers' livelihood as well.

Economics also explains the reluctance of the petrochemical industry to deal effectively with its toxic waste. The only practical, though far from satisfactory, way to keep toxic chemicals out of the environment is to destroy them—in specially designed incinerators, for example. This process, however, is so expensive—as much as two thousand dollars per metric ton—that if it were to be applied to the total annual tonnage of toxic chemicals (an estimated two million six hundred and fifty thousand tons) it might cost about five and a half billion dollars, an amount larger than the annual profit of the thirty largest American chemical companies, which include most of the nation's petrochemical industry. Proper treatment of its waste would thus force the industry to raise prices and face serious competition from the natural products that it has replaced.

In the end, the decisions that have so gravely affected the environment have also had serious economic effects, because they govern a factor that is closely linked to both the environment and the economy—the system of production. In a free-market economy, capital tends to be invested in those production enterprises which promise to yield the greatest return in the shortest time. Since the social interest in environmental quality or long term economic efficiency is not represented in such investment decisions, neither of these desirable re-

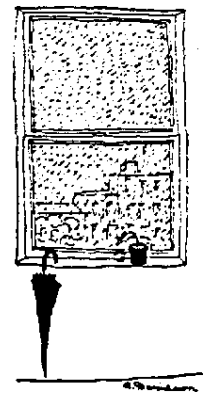


sults is likely to be achieved by them.

There seems to be a paradox embedded in the conclusion that most, if not all, environmental pollution is the outcome of decisions guided by free-market forces. It is often argued, after all, that the market operates—automatically, in the best of circumstances—to seek out those decisions which make the most efficient use of the available resources. And one of the well-justified claims for ecological processes is that *they* are characteristically efficient: there are, after all, no "wastes" in the ecosystem. If the present system of production is counter-ecological, it must be wasteful; if this is so, new systems of production, more closely guided by ecological principles, ought to be more efficient than those devised by the present market-guided system. Why then haven't they attracted investors and entered into successful competition with the present system?

The over-all economic efficiency of the new technologies that have transformed production since the Second World War—and have polluted the country—is unmistakable. Considerably more profitable than the technologies they have replaced, the new ones have generated a more than fourfold increase in total production (as measured by the gross national product) since 1950. However, the improvement in efficiency responsible for this achievement has been unbalanced. While the efficiency with which labor is used—that is, the value of the product yielded per hour of a person's labor—has increased a great deal, the corresponding productivity of capital and natural resources such as energy has declined. For example, the postwar substitution of plastics for leather has displaced an industry characterized by low labor productivity and high capital productivity with an industry characterized by high labor productivity and low capital productivity. To generate the same value of product, the plastics industry uses about a fourth as much labor but ten times as much capital as the leather industry. The disparity between the two industries' energy productivity—the amount of energy used to produce a given value of product—is even greater: the plastics industry uses about thirty times as much energy as the leather industry.

However, if one takes a more fundamental approach to the problem of environmental quality by recognizing that it is inherently linked to the technology of production, one can find ways of improving both the economy and the environment. The electric-power industry provides an informative example. The power industry is a notorious source of pollution: responsible for a great deal of environmental dust, sulfur dioxide, and nitrogen oxide; contributing considerably to acid rain; and generating the threat of nuclear disasters. In the United States, the industry is also in a precarious economic condition: the utilities' heavy investment in huge power plants—especially nuclear plants—has driven the cost of producing electricity sharply upward and has threatened some of the companies with bankruptcy. (A *Business Week* cover story has asked the question "Are Utilities Obsolete?") A major reason for these economic difficulties is that the present technology of electric-power production is highly centralized. Typically, each new plant is very large and requires a huge capital investment—billions of dollars. The plant is so large because it represents an investment in the capacity needed well into the future. Consequently, when a new plant begins to operate, the system inevitably has an excess capacity, and for a time part of the capital investment yields little or no return. Moreover, the transmission system that distributes electricity from central stations is costly and consumes a significant fraction of the power. Finally, centralized power plants are inherently inefficient, because, for inescapable thermodynamic reasons, two-thirds of the energy available from the fuel is dispersed into the environment. This means that the industry wastes two-thirds of the fuel that it uses, and causes three times as much pollution per unit of useful energy produced as it would if the wasted energy could be recaptured for use.



The heat discarded by a central power station could readily be recaptured and used—to heat homes, for example. But large centralized plants cannot be used for this process—cogeneration—because heat can be transmitted effectively only over short distances. No one wants to live such a short distance from a power plant, especially if it is nuclear. (Some people are in this unhappy position. For example, a nuclear power plant in Gorki, in the Soviet Union, provides heat for that city; its presence must have been causing a good deal of concern since the Chernobyl disaster.) By redesigning the technology of electrical production in keeping with sensible ecological principles, both environmental and economic improvement can be achieved. What is needed is to decentralize the production of electricity and install cogenerator plants just large enough to meet the local demand for heat and electricity. With the cogenerator operating at a much higher level of both economic and thermodynamic efficiency than a conventional power plant, fuel consumption is reduced, and the environmental impact and the cost of energy are decreased.

Similar environmental and economic gains could be achieved by reorganizing agricultural production along ecological lines. For example, it has been found that the net economic returns of large-scale Midwestern organic farms, which use no fertilizer or pesticides, are equal to the returns of otherwise similar conventional farms, which use a great deal of these agricultural chemicals. This represents an economic gain for the organic farmers, since with lower production costs they are less dependent on bank loans and therefore less vulnerable to bankruptcy. Similarly, if the crop system were properly redesigned to produce both food and ethanol (a solar fuel, and thus renewable) the farmers' income could be diversified and national energy production enhanced.

These gains can be achieved only if the social need for both environmental quality and economic growth is allowed to govern the choice of production technology. Typically, measures designed to meet such a need require a relatively large initial investment. This is a serious hurdle, which people who would benefit most—the poor—have difficulty in overcoming. Another hurdle is the relatively slow rate of return on some of the necessary investments. If such an investment—for example, the relatively slow restoration of impoverished soil through a transition to organic farming—must compete with an existing investment that yields quick profits, it is certain to be ignored. However valuable to society, the investment is not likely to be made if it must compete in the free market, which favors large-scale investments

over decentralized ones, and short-term over long-term returns.

PERHAPS the most profound question raised by environmental issues is to what extent the choice of production technologies should be determined by private economic considerations and to what extent by social concerns like environmental quality. These values are in sharp conflict. There appears to be a broad consensus that it is in the national interest to restore the quality of the environment, and the resultant legislation confirms the general impression that achieving this goal is a social, governmental responsibility. And, as we have seen, significant environmental improvement requires the proper choice of technologies and systems of production, so that this choice, too, becomes a social responsibility. Yet in our free-market economy the right to make such a choice is in private, not public, hands, and this is a right that very few Americans would challenge.

The recent entrepreneurial history of the United States Steel Corporation (now renamed USX) illustrates what can happen in these circumstances. In the nineteen-seventies, the company developed a plan to build a large, modern, low-pollution steel mill on Conneaut Lake, in Pennsylvania—a socially useful way to reduce both steel imports and pollution. Then, in 1982, with the price of steel driven down by cheap imports and the price of oil rising, U.S. Steel decided to buy the Marathon Oil Company, for about six billion dollars. The Conneaut Lake plant was never built. By 1985, fifty-four per cent of the company's business was in oil and gas, and only thirty-five per cent in steel. In July of 1986, the company dropped the word "Steel" from its name in favor of the ambiguous "X." The economist Robert Reno has commented:

> Now, it is arguable whether the best interest of the nation would have been better served if U.S. Steel had reinvested in modernized steel plants rather than purchasing Marathon Oil. Anyway, there's no law that says corporations must choose national interests over those of their stockholders.

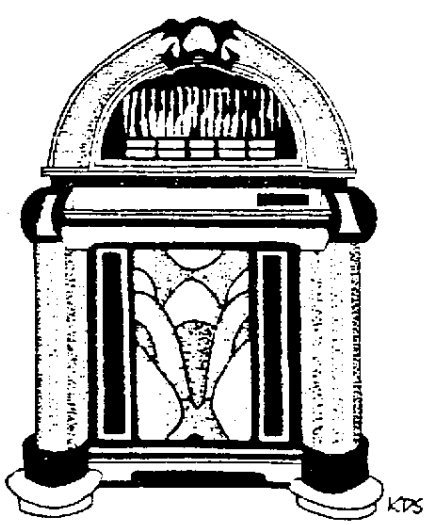
In fact, the company's legal obligation is not to the nation but to its stockholders, and that obligation is to produce not steel but profits.

This is, after all, the meaning of "free enterprise": the owner of capital is at liberty to invest it in any enterprise—whether it produces steel, chemicals, or oil—that offers the investor the most promising rate of return, the greatest market share, or some other private advantage.

The institution that largely determines the course of production technology in the United States—the corporation—is itself a peculiar amalgam of social and private features. In one sense, a basic purpose of the corporate form is social: to accumulate from a relatively large number of people an amount of capital far larger than that available from any one person. Moreover, almost all the earliest American corporations were chartered for a specific social purpose—constructing a canal, a bridge, a turnpike, or establishing a bank—that required large, collective capitalization. Today, corporations may be chartered for any legal purpose, and thus have the right to determine privately how their socially collected capital will be invested. However, corporations are certainly still social in their effects—not only on the environment but on employment, wages, and working conditions as well. Yet with respect to their control corporations are private, for they are governed by a small, self-perpetuating group of officers, who have no general accountability to society except for adherence to relevant government regulations, or—apart from profitability—to the stockholders who own the corporation.

The conflict between the modern corporation's social role and its private control led Adolf A. Berle and Gardiner Means to declare, in their classic work "The Modern Corporation and Private Property":

> The economic power in the hands of the few persons who control a giant corporation is a tremendous force which can harm or benefit a multitude of individuals, affect whole districts, shift the currents of trade, bring ruin to one community and prosperity to another. The organizations which they control have passed far beyond the realm of private enterprise—they have become more nearly social institutions.



From their detailed analysis of this situation, Berle and Means concluded that the separation of corporate ownership from control places society "in a position to demand that the modern corporation serve not alone the owners . . . but all society," and that "it remains only for the claims of the community to be put forward with clarity and force."

The date of Berle and Means' work—1932—is significant, for it suggests that the shattering impact of the Great Depression on confidence in the free-market system had impelled them to seek alternatives. Since then, potential critics have been, if not silenced, at least inhibited by the remarkable vitality of the American economy after the Second World War: by the dazzling new products, and by the growth of national and private wealth. Now that the attendant social ills—persistent unemployment, insufficient affordable homes, pollution, and the threat of nuclear annihilation—have become more evident, the silence has been broken. For example, the recent Catholic bishops' pastoral letter on the economy, citing Thomas Aquinas, asserts, "No one can ever own capital resources absolutely or control their use without regard for others and society as a whole. . . . Short-term profits reaped at the cost of depletion of natural resources or the pollution of the environment violates this trust." The bishops' letter reflects the 1981 encyclical "On Human Work," in which Pope John Paul II asserted, on moral grounds, that ownership does not justify exclusive control of production facilities: ". . . in consideration of human labor and of common access to the goods meant for man, one cannot exclude the socialization, in suitable conditions, of certain means of production." One can, of course, embellish these observations and arguments with a doctrinal term—socialism—and embrace or dismiss them by reacting to that term. While this may satisfy one's ideological convictions, neither approval nor disapproval can alter the reality, which, as we have seen, is that substantial environmental improvement has occurred only when the choice of productive technology was open to social governance.

The New Deal's response to Berle

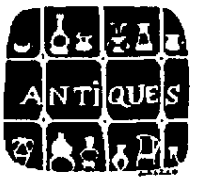
and Means' statement concerning the "claims of the community" on the corporations was regulatory legislation, then applying especially to banking and securities. This served as a model for subsequent regulatory measures, which reached a peak in the environmental legislation of the nineteen-seventies. These social interventions into corporate activity have been proscriptive rather than constructive: they tell the corporations what not to do rather than what should be done. Yet certain provisions of the new environmental legislation do in fact at least imply that environmental improvement may be achieved by the socially mandated choice of production technology. Thus, the basic instrument created by environmental legislation, the environmental-impact statement, is required to include a presentation of "alternatives to the proposed action" when that action would have an unavoidable adverse environmental effect. This provision implies that in, say, a public hearing on a trash-burning incinerator that would unavoidably emit dioxin into the environment a citizen could call for a decision mandating the choice of a technology that would separate and recycle trash rather than burn it. The banning of the use of DDT in agriculture or of PCB in manufacturing is a concrete, if relatively narrow, example of this approach. Opportunities, then, do exist within the framework of environmental legislation which, though they have been little used thus far, would permit at least the public weighing of alternative choices of production technologies.

Since conventional environmentalism is preoccupied with controlling emissions rather than with changing the production processes that generate them, economic considerations are usually reduced to what is called a cost-benefit analysis: the cost of the necessary controls is compared with the value of the benefits (to human health, for example) generated by a reduction in the level of pollution. Such an analysis attempts to give a social aim—the protection of the environment and of public health—dollar dimensions. Transformed into a pseudo-economic value, the social value can then be compared, it is supposed, with other economic factors, like the cost of controls, and some "cost-effective" balance struck.

An illuminating example of the moral booby traps built into the cost-benefit philosophy is provided by the E.P.A.'s recent justification for further reducing the lead allowed in gasoline. The E.P.A. carried out a cost-benefit analysis by totting up the cost of more expensive methods to boost octane and refinery changes needed to replace lead in gasoline (about six hundred million dollars in 1986) and comparing it with the monetary value of less engine damage from the lead additives, better fuel economy, reduced emissions of other conventional pollutants, and savings in the cost of medical care and compensatory education for children suffering from the physical and cognitive effects of lead poisoning (a total of about two billion dollars in 1986). The E.P.A. analysis concluded that the dollar value of the benefits of reducing lead in gasoline was more than three times the cost—clearly, a bargain to be snapped up. In those terms, the decision seems to have no more moral content than choosing one brand of breakfast cereal over another. Suppose, however, that a new medical advance were to sharply reduce the cost of treating lead poisoning, and so bring the dollar value of the benefits below the cost of controlling lead. What then? Would this new cost-benefit balance justify continued lead pollution? The apparently "objective" cost-benefit approach is thus quickly engulfed in deep moral issues. Should society attempt to mitigate *all* human suffering, regardless of cost? On the other hand, since social resources are limited, is it not reasonable to alleviate suffering in keeping with some measure of effectiveness? If a monetary measure is objectionable, what better measure can be used? It is, of course, unreasonable to ask the E.P.A. to answer these questions, which have frustrated numerous efforts over many years to answer them. But it is not unreasonable to insist that these issues be acknowledged rather than reduced to a trivial, easily dismissed monetary "solution."

Risk-benefit computations involving toxic pollutants have a similar outcome. Since the pollutants' ultimate effect can often be assessed by the number of lives lost (from cancer caused by an environmental carcinogen, for instance), the risk-benefit analysis requires that a value be placed on a human life. Some economists have proposed that the value should be based on a person's lifelong earning

power. It then turns out that a woman's life is worth much less than a man's, and that a black's life is worth much less than a white's. In effect, the environmental harm is regarded as smaller if the people it kills are poor—a standard that could be used to justify situating heavily polluting operations in poor neighborhoods. And, in fact, this is an all too common practice. Thus, thinly veiled by a seemingly straightforward numerical computation, there is a profound, unresolved moral question: Should poor people be subjected to a more severe environmental burden than others, simply because they lack the resources to evade it? Once again, what is at issue is not to resolve this question but to allow that it be asked. These examples warn us that environmental considerations are likely to raise troubling social issues—issues that in recent practice have been swiftly reduced to "solutions" by forcing them into the Procrustean bed of the free-market economy.



Recognition that significant environmental improvement depends on social rather than private governance of production decisions helps us understand why the considerable effort to improve the environment has had so little effect. This effort, however forceful, meets a politically immovable object: the conviction, powerfully embedded in American society, that the decisions that determine what is produced and by what technological means ought to remain in private, corporate hands. In the United States, there appears to be a powerful taboo against even public discussion, let alone criticism, of this principle. Confronted by the taboo, the environmental movement has splintered into a series of separate, more palatable campaigns.

Another consequence of this unresolved confrontation is that environmental organizations have been drawn toward explanations of the environmental crisis that avoid its origin in economic forces and appeal instead to the principles of ecology. Thus, on the assumption that the global ecosphere is a closed system of limited capacity, some environmentalists claim that the key to environmental quality is population control. Similarly, on the assumption that ecological cycles are closed and self-sustained, other environmentalists maintain that people, too, should abide by this rule, and live in communities supported by their own local or regional resources. And others derive from these same considerations the conclusion that ecological improvement requires the imposition of controls on economic growth.

The "limits to growth" approach is based on a serious misconception about the global ecosystem. It reflects the notion that the earth is like a spaceship—a closed system, isolated from all outside sources of support and necessarily sustained only by its own limited resources. The earth, however, is not a closed, isolated system, for its behavior is totally dependent on the huge influx of energy from an outside source—the sun. (In fact, the same is true of the spaceship, for it relies on sunlight to generate the electricity that runs its machinery.) On the earth, solar energy creates the weather: the seasonal and daily changes in temperature; the moisture that the sun lifts from the oceans; the storms that carry rain and snow to the earth and replenish the lakes and rivers that feed the oceans. The weather, in turn, molds the physical features of the earth's surface, creating the ecological niches that living things occupy. Solar energy, captured by photosynthesis, sustains every form of life and drives the ecological cycles in which they participate. If an ecological cycle is viewed only as a static array of animals, plants, and microorganisms linked through the physical environment into a circular system, it appears to be closed, like a ring. But this image is misleading, for without the energy that the ecosystem receives externally, from the sun, the plants and animals would die; the circular system would disintegrate.

This misconception also leads to the notion that the earth, as a supposedly isolated system, is subject to the increasing chaos arising from the unavoidable increase in entropy. Entropy is a measure of disorder in a physical system which is bound to increase whenever energy is used to generate the system's only useful product, work. But this increase in disorder happens only in a system that is isolated from an outside source of energy. The fact is that in the earth's ecosystem entropy-increasing processes—for example, the combustion of fuel, the death and decay of living organisms—are reversed by the external supply of solar energy, which regenerates burnable organic matter through photosynthesis. The organic matter, in turn, provides the energy that drives the entropy-decreasing process of plant and animal growth. On the earth, solar energy counteracts entropy.

In the abstract sense, there is a limit to economic growth, yet this limit is determined not by the present availability of resources but by a distant limit to the availability of solar energy. It is true, of course, that the ecosystem occupying the earth's thin skin and the mineral deposits underlying that skin are essential to economic production and that they are finite. It is also true that economic growth is limited by the finite amounts of those essential resources. However, since mineral elements are indestructible they can be recycled and reused indefinitely as long as the energy necessary to collect and refine them is available. And precisely this is done when the resource is sufficiently valuable: despite extensive dispersion, well over half of all the gold ever mined is still in hand today. Hence the ultimate limit on economic growth is imposed by the rate at which renewable solar energy can be captured and used. If we ignore the exceedingly slow extinction of the sun, this limit is governed only by the finite surface of the earth, which determines how much of the energy radiated by the sun is actually intercepted and is therefore capable of being used. How close are we to this limit? It has been estimated that the solar energy that falls annually on the earth's land surface is more than a thousand times the amount of energy (from fuels and hydroelectric and nuclear power) now being used annually to support the global economy. Of course, because of the relative inaccessibility of some parts of the earth not all the solar energy that reaches the planet could be used. If, let us say, only ten per cent of the solar energy falling on the land could be captured, it would still be possible to expand our present rate of energy use perhaps a hundredfold before encountering the theoretical limit to growth. Even if this figure should turn out to be somewhat optimistic, it seems clear that at present we are nowhere near the limit that the availability of solar energy will eventually impose on production and economic growth. That distant limit is simply irrelevant to current policy decisions. The issue we face, then, is not how to facilitate environmental quality by limiting economic development but how to create a system of production that can grow

and develop in harmony with the environment.

There have been lively debates over whether environmental degradation can be reversed by controlling the growth of the world population. A decade ago, many if not most environmentalists were convinced that population pressure and "affluence," rather than inherent faults in the technology of production, were the chief reasons for environmental degradation. Since then, the hazards dramatized by Chernobyl, Three Mile Island, Seveso, Bhopal, Love Canal, and Agent Orange have convinced many people that what needs to be controlled is not the birth rate but the production technologies that have engendered these calamities. In the last few years, however, the notion of population control has been given a new impetus, not so much from popular support as from the declarations of national environmental organizations and some of their leaders. Several examples are worth noting. Richard D. Lamm, the ex-governor of Colorado, who is a leading environmentalist, has frequently pleaded for population control, demanding an end to the flow of illegal immigrants into the United States from what he calls "never-to-be-developed countries," and urging on the terminally ill a "duty to die." In support of these ideas, he cites Aristotle: "From time to time it is necessary that pestilence, famine, and war prune the luxuriant growth of the human race." Garrett Hardin, a frequently cited environmentalist who is also a major proponent of population control, once gave this very general, ancient proposition an apparently ironic, distinctly modern—if astonishing—form:

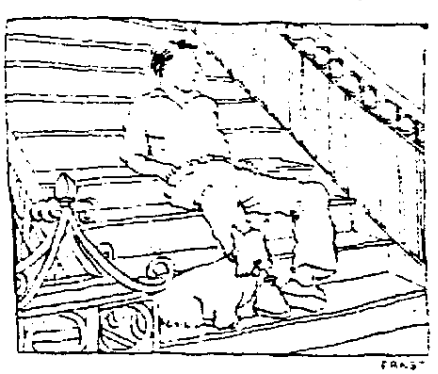
> How can we help a foreign country to escape overpopulation? Clearly, the worst thing we can do is send food. . . . Atomic bombs would be kinder. For a few moments the misery would be acute, but it would soon come to an end for most of the people, leaving a very few survivors to suffer thereafter.

For a more reasoned support of population control, we can turn to Russell W. Peterson, the former president of the Audubon Society, which is a major environmental organization:

> Almost every environmental problem, almost every social and political problem as well, either stems from or is exacerbated by the growth of human population. . . . As any wildlife biologist knows, once a species reproduces itself beyond the carrying capacity of its habitat, natural checks and balances come into play. . . . The human species is governed by this same natural law. And there are signs in many parts of the world today—Ethiopia is only one of many places, a tip of the iceberg—that we *Homo sapiens* are beginning to exceed the carrying capacity of the planet.

Examples can be readily cited to show that Peterson's conclusion is wrong, and that, quite apart from moral considerations, Hardin's Swiftian proposal to use nuclear weapons as a contraceptive device is therefore misguided. It is useful to remember that people in other countries did not go hungry because they sent food to Ethiopia to relieve the famine—that what was sent to Ethiopia was *surplus* food. In fact, the world produces more than enough food to feed the total world population. Total world production of food, equally distributed to the global population, would today provide everyone with more than enough for the physiologically required diet. According to a recent estimate by the United Nations Food and Agriculture Organization, the world now produces enough grain alone to provide every person on earth with thirty-six hundred calories a day—more than one and a half times the calories required in a normal diet. Enough grain is produced to give everyone on earth two daily loaves of bread.

Famine is caused not by a global food shortage but by the grossly uneven distribution of the global food supply. This is not an ecological phenomenon but a political and economic one. Neither England nor Haiti produces enough food for its own population, but hunger is much more prevalent in Haiti than it is in England, because Haiti cannot afford to import enough food to make up this deficit, while England can. A more localized example of the economic origin of hunger comes from a 1967 study of the state of Madras, in India. The study found that about a third of the population consumed an amount of food well below the physiological requirements for protein and calories: those people were slowly starving. But the total food output of the state was sufficient to provide the entire population with ninety-nine per cent of the required diet. The problem was not an ecological imbalance between the size of the population and the size of the food supply. The problem was poverty: the well-fed people earned about fifty per cent more than the starving ones. In general, there is considerable evidence that in developing countries poverty encourages a high birth rate, for parents hope that enough children will survive the scourge of disease to support the family. The reason for malnutrition, starvation, and famine, then, is poverty, not overpopulation. Excess population is a symptom of poverty, not the other way around. Hunger and overpopulation are not ecological manifestations; they are signs of economic and political problems that can be solved, humanely, by economic and political means.



Many people have been attracted to the environmental movement by their dismay over the present state of human society. Some of them are interested not only in correcting the environmental abuses that erode the quality of life but also in establishing a new, happier way of living. They want to create better places to live and better ways to work. They regard industrial society as the root not only of environmental problems but of all social, political, and economic ones as well. They look toward ecology as a guide to the creation of a new culture, a new style of living. Kirkpatrick Sale, a prominent exponent of this view, wrote in *The Nation* that this style of living would be "rooted in the natural world, in harmony with natural systems and rhythms, constrained by natural limits and capacities and developed according to the natural configurations of the earth and its inherent life forms." Seeking to establish an ecologically harmonious way of life—for themselves, at least—some people return to the land, growing their own food, building their own homes and furniture, recycling their waste to the land. Others have a wider vision, seeking "self-reliance, not so much at the individual as at the regional level." This approach, "bioregionalism," envisions a society based on ecologically defined regions rather than on areas specified by political boundaries. It embraces the belief that such an ecologically founded society will have many laudable features: it will be cooperative rather than competitive,

spread out rather than centralized, interdependent rather than polarized, evolving rather than growing, peaceful rather than violent.

Certainly it makes ecological and, ultimately, economic sense to organize society in ways that harmonize with nature. Problems arise, however, when one attempts to translate this general proposition into practice. According to Sale, bioregionalism is achievable, because its appeal overrides conventional political distinctions, and thereby avoids polarization and opposition:

> The bioregional idea has the potential to join what are traditionally thought of as the right and the left in America because it is built on and appeals to values that, at bottom, are shared by those on both sides.

In effect, Sale hopes bioregionalism can eventually remake society and somehow overcome opposition from the powerful economic forces that now largely govern it. This would be a remarkable political conjuring trick, for there is no way to reorganize society along ecologically sound lines without directly challenging the powerful, politically conservative forces—more plainly speaking, the corporations—that now control the system of production.

The illusion that environmental improvement is a politically neutral issue is not new. When environmental quality first emerged as a public concern, in 1970, a major politician declared, "Ecology has become the political substitute for the word 'motherhood.'" The theory that conservatives and liberals will happily join forces to develop an ecologically sound society has been tested by an eminent practitioner of political realism, Richard M. Nixon. He discovered that even his Administration's modest environmental efforts were a serious threat to corporate power. In 1970, on signing the National Environmental Policy Act, President Nixon adopted the environmental issue as his own, promising a vigorous campaign to clean up pollution. He said, "The nineteen-seventies absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters, and our living environment. It is literally now or never." In his 1971 State of the Union Message, Nixon, still sounding like a crusading ecologist, declared that environmental quality would be the "third great goal" of what he called the New American Revolution. But less than a year later Nixon seemed to believe that environmentalism threatened the basic precepts of corporate power. In September of 1971, he indicated that he had made a complete reappraisal of his environmental policies, and told an audience of auto-industry executives that he would not permit concern for the environment "to be used sometimes falsely and sometimes in a demagogic way basically to destroy the system."

IN referring to the environmental impact of production technologies, environmentalists often speak of the "hard path" and the "soft path." The hard path—the huge, centralized technologies created without concern for their environmental impact—leads to nuclear power, chemical agriculture, and high-powered cars. The soft path leads to technologies more appropriate in scale and design to their human purpose and ecological setting—cogenerators, solar energy, organic farming and small cars, mass transit and bicycles. This distinction is useful, but it is incomplete; in reality, the soft path of ecologically appropriate technology is a hard political road, for those travelling it confront the real source of environmental degradation—the technological choice—and debate who should determine that choice, and for what purpose. And a soft political road, which avoids this debate, inevitably leads to the environmental hazards presented by the giant technologies.

In the United States, the major environmental organizations are aware that in order to influence the resolution of environmental issues they need to find a way of participating in the political process. But they have generally chosen to travel the soft political road, which evades the issue of who should govern the choice of productive technology. This is evident in the recently published "An Environmental Agenda for the Future," by a group of ten self-described "leaders of America's foremost environmental organizations." The agenda recognizes the need to confront the root causes of environmental degradation, stating that "because the laws and regulations often have not dealt with root causes, they have been inadequate to cope with added problems that have arisen, partly from new technologies." Given this laudable intention, and what we now know about the root cause of environmental pollution, one would expect the environmental leaders to guide us toward the future by proposing national policies such as these: that the present reliance on nonrenewable

energy sources, and especially nuclear power, be replaced by renewable solar-energy systems; that the present chemically based system of agriculture be replaced by a system based on organic farming; that the inherently dangerous petrochemical industry be rolled back, its products and processes replaced by ones more compatible with the environment; that the nation's present heavy dependence on cars and trucks be replaced by a vast expansion of railroads and mass-transit facilities. However, the agenda offers a policy statement only with respect to population control: "The Administration should establish formal population policies, including goals for the stabilization of population at a level that will permit sustainable management of resources and a reasonably high quality of life for all people." Indeed, the agenda takes a gingerly approach to any measure that calls for socially mandated changes in the technology of production. For example, although favoring a shift toward renewable energy, the agenda recommends only that federal and state governments "develop successful strategies," rather than recommending a formal policy, as in the case of population. Similarly, according to the agenda, organic farming should be "researched and encouraged," but no political action is proposed to actually put this advantageous technology into practice.

The agenda appears to reflect the environmental leaders' effort to adjust the goals of environmentalism to the reality of Washington politics. As they see it, the reality is this: To obtain legislation that would improve environmental quality—by urging more stringent pollution standards, for example—a majority of Congress must be won over. But legislators are subjected to the influence of well-financed industrial lobbyists, who fiercely resist such restrictions on their companies' operations. In the past, these battles have often been lost by the environmentalists or, at best, have produced a legislative compromise. The alternative to lobbying is litigation—a lengthy, costly, and often inconclusive process. Thus far, clearly, neither effort has done much to improve the state of the environment.

In recent years, with an Administration that strives for minimal government programs in all but military affairs, environmental lobbying has seemed particularly fruitless. The environmental organizations, which have found themselves facing mounting costs and diminishing returns, have accordingly shown a tendency to seek less frustrating—and less costly—routes to environmental improvement. The main outcome has been the formation of small committees, composed of leaders of environmental organizations and corporate executives, that seek to work out compromise positions.

A good example is the Acid Rain Roundtable, a twelve-member group representing environmental organizations and power companies. In 1985, the Roundtable reported the results of a study that it had commissioned to devise "cost-effective programs" for the reduction of emissions of sulfur dioxide and nitrogen oxides from power plants. The study concludes that a reduction of twenty-six per cent in sulfur-dioxide emissions and twenty per cent in nitrogen-oxide emissions could be achieved at an annual cost of about two billion six hundred million dollars. The study opposes the strategy of reducing sulfur-dioxide emissions by installing scrubbers, which are regarded as too costly. According to the study, a more cost-effective solution is to cut back the burning of high-sulfur coal—a step that would reduce coal mining in the Midwest and northern Appalachia. Concerning the resultant unemployment, one Roundtable participant notes that the study was directed toward ways "to address miner unemployment by means other than mandating the installation of scrubbers." The report proposes to aid the miners who would lose their lifelong jobs by helping them obtain unemployment and health insurance for one year after they are thrown out of work. Regardless of the merits of the compromise recommended by the study, its basic structure is clear: it relieves the power companies of the cost of installing scrubbers, or of the competition threatened by local cogenerators—both facilities capable of reducing pollutant emissions—and shifts the economic consequences of achieving a modest reduction in emissions onto the miners. According to one Roundtable member, the study was designed to "break the legislative deadlock." Not surprisingly, the United Mine Workers is not one of the member organizations of the Roundtable, although, as important parties to the issue, they would receive respectful attention if it were to be resolved by conventional democratic means, in the legislature.

One result of the national organizations' tendency to travel the soft political road has been the appearance of a new "grass roots" environmental movement. This movement has arisen out of the direct impact of environmental pollution on community life. It is concerned chiefly with toxic chemicals, toxic-waste dumps, and dioxin-producing trash incinerators. It is exemplified by Love Canal, in Niagara Falls, New York, where local residents, who had been exposed to toxic chemicals, organized to demand the actions that finally led to the evacuation of the area and some compensation for their financial losses. Lois Gibbs, who led that fight, has formed a national federation of similar community groups. For such groups, the front line of the battle against chemical pollution is not in Washington but in their own communities. For them, the issues are clear-cut and are not readily compromised: A waste-management company decides to build a trash-burning incinerator, but the community, fearful of the health effects, doesn't want it. A chemical company keeps dumping toxic wastes in a leaky lagoon, but the community wants the practice stopped and the lagoon cleaned up. In these battles, there is little room for compromise; the corporations are on one side and the people of the community on the other, challenging the corporation's exclusive power to make decisions that threaten the community's health.

Thus, confronted by powerful corporate opposition, the environmental movement has split in two. The older national environmental organizations, in their Washington offices, have taken the soft political road of negotiation, compromising with the corpora-

tions on the amount of pollution that is acceptable. The people living in the polluted communities have taken the hard political road of confrontation, demanding not that the dumping of hazardous waste be slowed down but that it be stopped; not that dioxin-producing incinerators be equipped with unworkable emission controls but that they be abandoned in favor of more benign recycling technology. The national organizations deal with the environmental disease by negotiating about the kind of Band-Aid to apply to it; the community groups deal with the disease by trying to prevent it.

It can be argued, of course, that, given the considerable power of the polluters, it is better to compromise with them, in the hope of making some partial improvement, than to engage them in a battle, which may only end in frustration. On the other hand, there is a danger that in the course of negotiating a compromise the environmental organizations will become hostage to the corporations' power, and will experience the Stockholm Syndrome, in which hostages take on the ideology of their captors. Perhaps something like this happened to Jay D. Hair, the executive vice-president of the National Wildlife Federation, which is heavily involved in "enlightened and responsible dialogue with corporate leaders." Hair recently admonished environmentalists that "our arguments must translate into profits, earnings, productivity, and economic incentives for industry"—precisely the arguments of corporate executives against the regulation of pollution.

Because the effort to improve the environment is so closely linked to the decisions that govern the technology of production, it is inevitably drawn into the realm of politics. Though technological choices are often thought of as being outside the realm of public policy or politics, and driven instead by "objective" scientific considerations, the evidence contradicts this view. That high-compression automobile engines are particularly powerful and generate smog is certainly an objective scientific fact. The decision to manufacture such an engine rather than one that is less powerful but does not produce smog is, however, not a scientific necessity but a human choice. When the auto companies decided to build high-compression engines, the choice, as we know, was motivated by a private interest—higher profits. But their decision created a social problem—smog. When the decision was made, no questions were asked about the environmental effect of the new engines, and their social impact was revealed, too late, by the blanket of smog that covers the cities.

It is, of course, quite possible to choose a technology on the basis of its social consequences. When environmentalists speak of "appropriate technology," they have in mind production methods that not only enhance environmental quality but fulfill such other social purposes as conservation of energy and material resources and humane conditions of work. The social significance of a technological decision is much wider than its impact on environmental quality. The series of decisions that substituted plastics for leather, for example, aggravated not only environmental pollution but unemployment as well, for the plastics industry uses more capital and less labor than the leather industry did. In this sense, social guidance of technological decisions is vital not only for environmental quality but for nearly everything else that determines how people live: employment; working conditions; the cost of transportation, energy, food and other necessities of life; and economic growth. And so there is an unbreakable link between the environmental issue and all the other troublesome political issues.

Efforts to develop a frankly political approach to the environmental issue—that is, to seek political power in order to use it to solve the environmental crisis—inevitably confront this linkage to the whole of politics. The most striking example is the brief but remarkable history of the Green Party in West Germany. In 1983, only four years after it was founded, the Green Party obtained five and six-tenths per cent of the vote in the national election and won twenty-seven seats in the Bundestag. The Party began with an ecological outlook that emphasized not only the hazards of pollution but also the dangers of the ultimate ecological disaster—nuclear war. The Greens' anti-war position was an important source of votes, for neither the Social Democrats, who were then in power, nor the opposition Christian Democrats were against the expanding American nuclear presence in West Germany and the rest of Europe. In the 1983 election, peace-oriented voters, who were not necessarily preoccupied with ecological issues, found in the Greens a way to express this concern. This helped the Greens appeal to a group of voters considerably broader than ecological activists.

Yet the Greens' preoccupation with ecology was also a serious political drawback. The 1983 election occurred at a time of high unemployment, unprecedented in recent West German history. Some Greens believed that the best way to reduce environmental degradation was to lower the level of industrial activity, which they regarded as inherently anti-ecological, and this belief was translated into an open disregard for the demand for more jobs; after all, more jobs meant putting more people to work in polluting factories. Naturally, unemployed workers and many voters who sympathized with them were not attracted to the Greens.

Thus, from its inception the Green Party, like the environmental movement generally, ran head on into the firm bond linking ecology and economics. In the last few years, this confrontation has given rise to a basic split within the Party. One group consists of the "fundamentalists," who adhere to what they regard as basic ecological principles: advocacy of a social structure based on "unity with nature;" a spiritual devotion to harmonious relations among people and nations; respect for all forms of life. At a recent Green convention, one member of this group pleaded passionately for a resolution condemning the "slaughter" of thousands of frogs in biology laboratories, comparing it with the Holocaust. The fundamentalists are concerned chiefly with combatting pollution and fostering a transition to renewable resources, "soft" alternative technologies, and a way of life appropriate to these. The other group consists of the "realists." They recognize

the fundamental origins of ecological and other problems in the political control of the economy. They are concerned not only with the technology of production and its impact on both the environment and jobs but also with which social class holds the governing power. The realists are linked to labor unions, and most of them favor political alliances—with the Social Democrats, for example, whose positions on environmental and peace issues have of late moved closer in some respects to the Greens' position.

In October of 1985, the split between the fundamentalists and the realists took a dramatic turn when, over the objections of the national Green leadership, the realist-led Green Party of the industrial state of Hesse agreed to join the Social Democrats in a governing coalition. (The coalition broke up early in 1987 over a disagreement about a nuclear facility.) The Christian Democrats quickly attacked the Hesse Social Democrats for making a pact with "fanatical opponents of our free economy." In the heat of the accompanying debate, the fundamental political issue generated by ecological concerns became plain when a Christian Democrat who opposed the coalition declared that major corporations would leave Hesse, because "free companies decide where they want to invest." Thus, the history of the Green Party is a lively and effective dramatization of the links that tie ecology to economics and both to politics. It also illustrates the ease with which a failure to understand these links properly can lead to a politics that rises in defense of laboratory frogs but not unemployed workers.

Italy provides a different example of environmental politics. In the 1985 elections, environmentalists organized "green lists" of candidates, and some were elected to office. While the Italian greens are strongly oriented toward environmental issues—in particular, opposition to nuclear power, to nuclear weapons, and to industrial pollution—most of them share the general political orientation of the Italian parties of the left. This leads to a kind of "red-green" situation, in which environmental concerns are joined to a broader left political program. In this sense, the green lists have also become important through the pressure they exert on the parties to adopt environmental positions; for example, recently they have helped to reverse the Italian Communist Party's earlier support for nuclear power. In turn, such developments may encourage environmentalists to work within the parties, and thus link environmental concerns more firmly with the rest of politics.

In the United States, environmental politics has followed a distinctive course. Here the environmental movement is part of the phenomenon that

since the Second World War has given rise to wave after wave of popular, issue-oriented movements: for civil rights; against nuclear-weapons testing; for women's rights; for gay and lesbian rights; against the war in Vietnam; for the environment; against nuclear power and for solar energy; for world peace. These movements have a good deal in common. All of them have arisen outside the arena of conventional politics, sparked by outsiders like Martin Luther King, Jr., and Rachel Carson rather than by established political figures. Their level of public support has typically gone through successive cycles of enthusiasm and apathy. At their height, some of these movements have achieved notable successes—the civil-rights and environmental laws, the nuclear-test-ban treaty, the new employment opportunities for women—all of them accomplished by nonelectoral means: marches, demonstrations, lobbies. Yet, as the record of the Reagan Administration shows, these successes can be quickly eroded when officials hostile to them are elected to power. Indeed, the movements' greatest failure is their inability to translate the millions of votes that their combined adherents represent into significant electoral power, and put people in office who will protect their gains and expand them.

A major reason for the tenuous connection between the movements and politics is that their issues have been consigned to the political ghetto that is reserved for "special interests." In a sense, this isolation is self-imposed, for the varied concerns are usually manifested—in a legislator's office, for example—as single-minded constituents, one pleading for peace, another for sexual equality, a third for environmentalism, on down the list. Each special pleading demands a special response, at best unrelated to the other issues, and often in actual conflict with them. Each of the issues is regarded as

a possible modifier of national policy but not as a creator of it—a correction in the course of the ship of state but not a motive force. Yet the issues that the movements represent, taken together, and added to those of the much older labor movement, constitute not only the major aspects of public policy but its most profound expression: human rights; the quality of life; health; jobs; peace; survival. What can unite these movements to enable them to exert an effect on national policy that expresses the profound political meaning of their collective issues?

The environmental experience suggests an answer. As we have seen, the obvious manifestations of the environmental problem—smog, toxic dumps, nuclear catastrophes—that set it apart as a "special interest" are but perceptible expressions of a deeper, underlying issue: how the choice of production technologies is to be determined. Here environmentalism reaches a common ground with all the other movements, for each of them also bears a fundamental relation to the choice of production technologies. Discrimination, for example, resembles pollution in that one of its major features—paying women and racial minorities less than white men—originates in decisions made by the managers of productive enterprises. Of course, other factors, social, cultural, and psychological, are involved, but the end result—wage discrimination—is, after all, an effective way of reducing production costs. Or, to look at this relationship from the other direction, if it were to be determined through some system of social governance that all the employees in an enterprise who do comparable work should receive equal pay, regardless of sex or race, a major effect of the social, cultural, and psychological forces that engender discrimination would be nullified. The connection between this common ground and the issues of peace and foreign policy is less direct but nevertheless substantial. It explains, for example, the apparent justification for the Administration's military belligerence—the insistence that force must be used wherever it is needed to support governments and political groups that, like the Administration, favor free-market principles of economic governance. In particular, it would be difficult to explain the Administration's deep-seated antagonism to the Soviet Union—which engenders the monstrous threat of global nuclear destruction—if it were not for the opposite views of the two govern-

ments on the stewardship of economic enterprises.

Perhaps the most useful outcome of the environmental experience is that it illuminates the relationship between the outward manifestations of the ills that trouble modern society and the common origin of those ills. But there are risks in expounding this relationship. Calling attention to their source may appear to minimize the importance of the immediate problems that initially attracted adherents to the cause, and so risk their ire. At the same time, an effort to transform the "special interest" into a critique of basic and even more troubling faults in the social structure is likely to intensify opposition to it. The path taken by Martin Luther King, Jr., in the last few years of his life is a cautionary example. At the height of his influence, King had won major victories and had acquired a broad following as the leader of a powerful attack on outward expressions of legally enforced racial discrimination: segregated schools and public facilities. Then, a few years before he was assassinated, he began to link racial discrimination to its origins and, thereby, to other social issues. He sensed, it seems, that blacks could not break out of their persistent social ghetto if they remained trapped, as a "special interest," in a political ghetto. And so he declared his opposition to the war in Vietnam, led a march of poor people (black and white) on Washington, and championed the cause of striking black garbagemen in Memphis. In this new role, King quickly became more controversial. He was out of his depth, it was said—taken in by political radicals and diverted from his true mission. But he died believing, it seems, that this new course had brought him closer to the heart of the problem he had set out to resolve: that beneath the legal basis of racial discrimination lay the deeper problems of poverty and violence; that the root of racial discrimination is also the root of poverty and war.

Neither the environmental movement nor any of the other issue-oriented movements have yet attempted to follow the road that Dr. King began to travel before he died. But the environmental experience powerfully illuminates that road—a historic passage toward a democracy that can exert its force on the germinal decisions that determine whether we and the place we inhabit will thrive.

—BARRY COMMONER