7 The Greening of Industry

Pollution is nothing more but resources we're not harvesting.
—Buckminster Fuller

The biggest challenge we have is convincing the public that we are their friends and not their enemies. . . . Everything can be cleaned up and managed in a very acceptable way with respect to the environment and the health of our people.
—Chief Executive Officer of the DuPont Company
Richard Heckert

A Large Company Looks Ahead but Stumbles with the Present

I first visited the headquarters of the 3M Company in St. Paul, Minnesota, in 1975. Best known to most Americans as the manufacturer of Scotch Tape and Scotch Gard, the 3M Company has for many years been an industrial leader in the production of many types of adhesives and coatings for industrial and consumer uses. The company also manufactures electronic circuits, pharmaceuticals, audio and video goods, and a variety of other products at facilities in 24 states and 22 foreign countries.

The company's environmental coordinator was pleased to receive me as a representative of the EPA. He did not hesitate to boast of the company's major investment in the construction of a new high-temperature incinerator. Using this new facility, the 3M Company could destroy many of the toxic wastes generated by its plants. In addition,

the company could offer incineration services to other firms that were also seeking better ways of disposing of these wastes.

This facility was coming on-line at a time when industry was seized with a need, nationwide, to destroy hazardous chemical wastes rather than place them in landfills where some would remain toxic for centuries. At that time the temperatures being reached at most of the incinerators throughout the country were too low for such destruction and allowed many unburned chemical products to escape into the environment. The 3M incinerator would avoid this problem.

While the incinerator was too new to have demonstrated its full potential, 3M officials were confident that this state-of-the-art device would solve many of their waste disposal problems. In addition, the publicity which they had disseminated about the facility was receiving very favorable reviews within Minnesota and in Washington. The company was rightfully claiming national leadership in the field of high-temperature incineration, for its incinerator was at the frontier of technology.

The 3M management had also developed another program which was in the early stages of implementation. The concept behind this new program called Pollution Prevention Pays, or 3P, was very simple. If individual employees could develop ideas to modify existing manufacturing approaches or could design new approaches which made sense economically and at the same time reduced the amount of wastes being generated, the 3M Company would give them special recognition. The company encouraged every employee to undertake this task, and a special review board of senior company managers evaluated the ideas presented by the employees.

When I returned to the 3M headquarters building 14 years later, I received a glowing report on the tremendous success of Pollution Prevention Pays, but I did not hear a word about the incinerator. By 1989, "waste minimization" as an alternative to waste disposal had become the most highly promoted slogan in Washington, and 3M had been the first manufacturing company to formally embrace the concept through its 3P program. Indeed, representatives of many other companies regularly visited 3M headquarters to learn about the program and to pattern their approaches after the 3P method.

According to officials of the 3M Company during my second visit, 700 projects under the 3P program had resulted in an annual savings of

over $400 million for company operations in the United States alone. At the same time, they pointed out that over the years these projects had prevented the discharge into the environment of 11,000 tons of air pollutants, 15,000 tons of water pollutants, one billion gallons of wastewater, and 388,000 tons of sludge and solid wastes. The changes had been made in four general categories: changes in the chemical formulations of products, modifications of production processes, redesign of manufacturing equipment, and recycling of materials which could be reused in production processes. Corporate management gave special recognition to projects which were innovative, incorporated original designs, or involved significant technical achievements.

Undoubtedly, many if not most of the projects would have evolved in the absence of the 3P program as the company tried to save money through improved technologies and complied with federal and state regulations limiting the discharges of pollutants. However, some of the approaches probably would not have been developed in the absence of the constant pushing of the 3P program by senior company officials. The program has also provided the 3M Company with a very impressive scorecard of concrete steps that have been taken on the initiative of 3M employees to reduce environmental contamination.

During my second visit the incinerator was not a topic of discussion for an understandable reason. Prior to my visit, I learned from the Minnesota Pollution Control Agency that the agency had just fined the 3M Company $1 million for improper operation of the incinerator. These faulty procedures apparently had allowed trace levels of pollutants considered hazardous by the state to escape into the atmosphere for many months or even longer. I can only surmise that company management had become overly confident in the advanced technology and did not pay enough attention to the human factors involved in day-to-day operations.

Also, I learned that 3M officials had concluded that in recent years they had not given adequate attention to the reductions of chemical emissions into the atmosphere at the company's manufacturing facilities, reductions beyond those called for in governmental permits. Many facilities, according to the officials, had been sited in relatively remote areas where air emissions presumably would not cause concern to the public, and therefore the company had assumed that additional steps would not be necessary.

However, in the mid-1980s the attitudes of federal and state environmental agencies, and of course the public, toward emissions of chemicals into the atmosphere regardless of the locations of the facilities had changed dramatically. Nationwide concern over toxic air emissions heightened when the EPA, in response to newly enacted legislation which had been supported by industrial lobbyists, required all companies to prepare reports for public release of their total emissions of a long list of those chemicals of greatest concern on a plant-by-plant and chemical-by-chemical basis. 3M, for example, reported that in 1987 its 50 plants in the United States had discharged 61.7 million pounds of these chemicals into the atmosphere. The company officials were quick to point out that in view of the broad diffusion of these emissions the resulting concentrations in populated areas were extremely low, and indeed seldom detectable.

Like many firms in 1989, 3M was responding to the pressures of the regulatory agencies and the public to reduce discharges of hazardous air emissions, as well as other types of emissions, into the environment. Just before my second visit to St. Paul, the company had announced its new 3P *plus* program. This concept adds specific pollution reduction targets to the 3P program with line managers responsible for seeing that the targets are met. Specifically, in 1989 the company committed to reducing discharges into the atmosphere by 90% within the 1990s through a combination of air pollution control equipment, substitutes for petroleum-based solvents, and greater emphasis on recovery and recycling of waste products. The company was confident it could achieve this ambitious goal since the company had made considerable progress in fulfilling a 1987 commitment to reduce air emissions by 70% by 1993.

The foresightedness of 3M in adopting the 3P program has been widely commended. Yet the same company stumbled with the routine operation of an incinerator. Also, the company is now recognizing that there are no environmentally "remote" locations in the United States, and even a handful of local residents deserve as much protection from air emissions as do large numbers of city dwellers.

Many other companies have environmental profiles comparable to 3M. Their programs for protecting the environment have many commendable features often pressing the state-of-the-art of pollution control to levels which government agencies had thought could not be

attained. Still, almost every major company has soft spots somewhere in its environmental activities which deserve more concerted attention by the company in the years ahead.

Environmental Outrage Engulfs a Small Company

Forty miles south of St. Paul lies Northfield, Minnesota. This rural community has been known to many as the home of Carleton College and St. Olaf College. The informal town slogan has been "Cows, Colleges, and Contentment." However, when I visited Northfield in late 1989, I was greeted by T-shirts picturing a dead cow lying on its back with its feet extended upward and a slogan reading "Cows, Colleges, and Carcinogens." The following words were on the back of the T-shirts:

> Sheldahl Inc., of Northfield, Mn., was among the worst in the nation at releasing known and suspected cancer-causing chemicals into the air in 1987. Associated Press.

Sheldahl was the largest major employer in Northfield with 950 workers at its facilities just north of the town. The company also had plants at three other locations in the United States and had financial ties to a large Japanese firm. For more than two decades the company had manufactured flexible electronic circuits for the communications, automotive, and aerospace industries at its Northfield facilities.

The company's manufacturing processes depended heavily on the use of solvents with carcinogenic tendencies. Other chemicals with particularly desirable electrical properties were dissolved into these liquid solvents. The solutions were washed onto metallic or other surfaces where the added chemicals remained permanently as a result of chemical interactions. The solvents were then either discarded (for example, boiled off the surfaces and exhausted out a stack) or captured and recycled to the extent possible.

According to company officials, over the years Sheldahl had relied on solvents which it considered to be not only technically and economically acceptable but also safe within the production plant and benign in the environment outside the plant. However, as concerns over the hazards of using solvents had increased during the early 1980s in

Washington and throughout the country, the number of solvents considered to be safe dwindled. The company considered methylene chloride to be the most environmentally acceptable of all the solvents which could be used in the process of laminating circuit boards. Methylene chloride has a particularly desirable feature of nonflammability. In some of the company's other processes, only flammable solvents were judged to be technically suitable, and special care was taken in handling these chemicals.

As indicated on the T-shirts, in the mid-1980s Northfield appeared on the EPA's list of cities with significant discharges of carcinogens, and specifically methylene chloride vapors. This chemical became the center of a controversy which penetrated every home in the community. This controversy was similar to clashes over toxic chemicals in other communities throughout the country which erupted when the EPA list of discharges was released.

The risks to the community from emissions from the plant were unknown. Methylene chloride administered to laboratory animals (through ingestion but not through breathing since ingestion experiments are much easier to conduct) at very high levels had caused tumors in some species but not in others. There was no scientific evidence that workers who breathed the chemical had or had not suffered long-term ill effects. The levels of the chemical present outside the plant boundaries were estimated by computer models using questionable assumptions as to the rates of discharge and the behavior in the atmosphere of methylene chloride, and there were no reliable monitoring data available to determine the levels of the chemical in the air within or outside the facilities. The company had reported to the EPA that a certain quantity of methylene chloride was used up in the production process, and it was simply assumed that most of the used materials escaped into the atmosphere.

Faculty members at Carleton College had examined the potential risk. They released an assessment of the hazard prepared by a student who had a very limited understanding of the concept of uncertainty, a concept which is inevitably involved in risk assessments. His poorly documented paper simply added to the controversy and at least temporarily weakened the credibility of the college scientists.

Many townspeople argued that any risk was unacceptable and that methylene chloride should no longer be used in the plant. Other residents worried about their jobs and urged careful consideration of the

economic implications of overreacting. The company had already agreed with the local labor union to reduce the quantity of methylene chloride being used by 40% within one year. The company argued that economically it was impossible to phase out the chemical completely for at least four years and suggested that in the interim the emissions be diluted at ground level by using a higher exhaust stack.

Meanwhile, the Minnesota Pollution Control Agency was struggling with the enforcement of its requirement that a "maximally exposed" person standing outside the plant would not be subjected to a risk of more than 1 in 100,000 chances of receiving cancer from exposure to the chemical. One popular interpretation of "maximally exposed" was that an individual would remain for an entire lifetime at the point of maximum concentration of the chemical along the fence of the plant. The state had great difficulty determining what that concentration should be. Everyone was scrambling to become quickly educated on the intricacies of risk assessment only to learn that science has severe limitations.

While the debate over the future of the Sheldahl plant continued, several conclusions from this and similar situations around the country seemed clear. The congressional requirement that all manufacturing facilities publicly disclose the amounts of chemicals being discharged into the environment has had a dramatic effect. It has forced companies to accelerate their plans, and in some cases first develop plans, to reduce chemical discharges. State authorities have awakened to their past neglect of chemical pollution problems. Individual citizens are beginning to realize that for many years they have been surrounded with the chemical by-products of an industrial society. Finally, most Americans seem to be reacting to these new revelations the same way they have reacted to smog: let's eliminate the chemical pollution if we can, but let's not worry about it if we can't. However, a few are more insistent: discharges must stop now even if we must shut down the facilities.

We should not be overly critical of the Sheldahl Company's neglect of chemical emissions in the past. After all, for many years state authorities had not been concerned. Small companies cannot be expected to have the array of experts available to the government. American industry had become accustomed to reacting to governmental requirements. Voluntary actions on the part of industry have not been a high priority, either by industry or by government—at least until now.

The Sheldahl Company along with many other much larger companies relied on methylene chloride as the most technically and environmentally acceptable solvent, and indeed it was preferable to many other possible choices. Understandably, Sheldahl sought to solve the problem in a way which would be least disruptive economically. Finally, there is considerable merit in the company's argument that the uncertainties associated with the risk estimates are so great that the debate over the *degree* of risk had become almost meaningless.

In the future, however, neither Sheldahl nor any other company can hide behind the excuse of not being aware of the possible environmental problems associated with chemical discharges into the air, into the water, or onto the land. Through the requirement for public disclosures of their discharges, all segments of American industry have been put on notice that they are expected not only by governmental authorities, but also by the American people, to reduce chemical discharges. Arguments will persist over the rate and extent of these reductions. But regardless of the inability of environmental advocates to demonstrate specific levels of risk, the commitment of American society to reduce exposures to toxics, however small, seems clear.

The Environmental Consciousness of the Chemical Industry

The attitudes and behavior of American chemical companies toward protection of the environment are dramatically different in 1990 than they were in the 1970s when the initial laws to control toxic chemicals were enacted in Washington and in many state capitals. Twenty years ago, aside from restrictions on the use of pharmaceuticals and pesticides, few regulatory barriers inhibited the development and sale of chemicals. Few companies took time to look beyond their internal staffs for advice on whether chemical products were safe since doing so might slow down their marketing activities. Now, judgments of many boards of directors and company managers on the values of products are based equally on marketability and environmental acceptability. This acceptability is defined by governmental agencies, by national scientific organizations, and by a greatly increased cadre of company environmental specialists.

Economic considerations always motivate private companies, and industrial managers now clearly understand that the costs of correcting mistakes from inadequate attention to environmental protection can be devastating to a company's profit margin. The costs to Union Carbide for the Bhopal accident, to Exxon for the Alaskan oil spill, and to Johns Manville as the target of the asbestos liability suits, for example, have been widely publicized. However, almost every company has faced less dramatic yet still substantial costs in coping with environmental problems. These problems have made lasting impressions on the approaches of American industrial leaders to the calculation of likely profits and losses associated with environmental considerations.

The Superfund legislation and related federal and state regulations together with a number of court decisions have clearly established the principle that a company which manufactures a chemical retains some responsibility for ensuring that the chemical does not harm humans or the environment—even if the chemical is sold to another company. This cradle-to-grave liability concept has sensitized all firms to the need for great caution in selecting processors, distributors, and disposers of their chemical products and their wastes and in ensuring that the recipients of their chemicals are committed to responsible environmental procedures. Similarly, some companies are now very wary of the practices of their suppliers of chemicals, lest the suppliers skirt environmental regulations and draw their purchasers into legal entanglements.

As would be expected, many companies protect themselves with elaborate insurance arrangements to cover financial difficulties resulting from environmental problems. Large corporations tend to opt for self-insurance, often setting up separate insurance entities within the corporate structures. Other companies seek protection through the insurance industry which has been doing a land-office business in this area. The insurance companies in turn may require manufacturers to take certain steps to reduce the likelihood of environmental problems. Then they adjust their rates in accordance with their assessments of the degree of risk involved.

Does this mean that all companies are now taking all possible steps to ensure that toxic chemicals will not harm the environment? Of course not. Every week companies are still being fined by governmental authorities for failure to comply with environmental regulations. The data released by the EPA in 1989 indicated that large amounts of

potentially toxic chemicals were being discharged into the environment. These data triggered the Sheldahl case and also led to the 3P plus program at 3M. They provide dramatic evidence that much more aggressive action needs to be taken by industry to reduce chemical discharges. Meanwhile, the continuing controversies over remediation of old waste sites often reflect recalcitrance on the part of many companies to clean up their sins of the past. This recalcitrance is often prompted or accentuated by difficulties in resolving liability issues among the manufacturing and the insurance companies which are involved. Still, the long-term costs of not complying with environmental regulations, including the intangible costs associated with tarnished corporate images among the public, are on the rise, and companies are less likely than in the past to seek ways to delay or avoid compliance.

Several types of pressures drive chemical companies toward more assertive behavior to embrace environmental protection. Many laws, regulations, and facility permits are in place to help define the limits of acceptable activities. Second, companies are concerned over liability suits or other citizen actions demanding compensation—by individual workers or customers who claim harm from coming into contact with chemicals, or by environmental groups or labor organizations which represent interests that extend beyond a single individual. Many companies, and particularly companies with product lines which emphasize consumer goods, such as Procter and Gamble, value highly their reputations among the American public. They do not want to be linked in any way with environmental problems which might damage their images and give competitors the slightest edge. Of course, within every company there are individuals at the board level, in management positions, and among workers who have strong personal commitments to environmental protection. They are capable of exerting pressure on companies to become environmentally responsible.

In the mid-1970s, as the EPA official responsible for assessing the environmental policies of chemical companies, I had a unique vantage point to observe the behavior of these companies firsthand. At that time it seemed clear that the government needed to stimulate and support efforts of companies to initiate environmentally responsible approaches. A few companies had assembled large environmental staffs to examine every facet of their activities, and they had strong capabilities to develop far better solutions to their own problems than solutions dictated by the

government. However, most companies were reluctant to divert financial resources to environmental activities in the absence of clear signals from the government as to steps they should take.

I soon became an advocate within the EPA for officially recognizing voluntary steps taken by industrial firms to protect the environment. Some companies had mounted elaborate programs for testing the environmental behavior of chemicals years before the EPA had legal authority requiring industry to carry out such tests. Other companies had developed environmental training programs for the employees of customers and suppliers long before the government had given any thought to such responsibilities. Still other companies had voluntarily pulled products off the market and suffered considerable economic penalties as they tried to develop safer products. Finally, some companies had made major scientific contributions toward developing a variety of modeling, monitoring, and toxicology tools for assessing environmental problems on a national basis.

The EPA lawyers were shocked at such an outrageous proposal—to commend a legal adversary. They argued that any acknowledgment that a company was making useful contributions to environmental protection would surely weaken the EPA's case if that company ever stepped out of line and, for example, violated the Agency's permit requirements at one of the company's facilities. Besides, they added, such an approach would send the wrong signal to the Congress, to environmental groups, and to the American public that the EPA was being duped by industry to believe that self-policing was realistic.

The lawyers carried the day. The government's approach to environmental protection was to be based on adversarial confrontation. The EPA would continue to work through the *Federal Register,* through legally binding discharge permits, and through the courts as necessary to require industry to respond to a command and control system of environmental protection. Should industry decide to take steps beyond those that were required, such steps would be welcomed—but they would not count on the EPA's scorecard. The EPA's scorecard would only reflect legal transgressions.

Not surprisingly, industry's response has largely been to do what is required or what may be required in the near future. However, the EPA lawyers were wrong. Industry can do a lot more, and official recognition in Washington of responsible corporate behavior could be an important

inducement for a greater environmental consciousness throughout the industrial world. Positive reinforcement can work. Just because you commend a company for certain steps doesn't mean you ignore transgressions it may commit.

Industry Efforts to Reduce Toxic Wastes

"Minimization" of toxic wastes is one of the most popular topics today in environmental circles and is one area where the views of government and industry are converging. If industry produces less waste, America will encounter fewer pollution problems.

The Congress, the EPA, state legislators, and state environmental agencies have given waste reduction top priority. As illustrated by the 3M experience, many industrial firms believe that they can improve their competitiveness by giving greater attention to the technical opportunities for reducing wastes, particularly in view of the ever-increasing costs of waste disposal. Of equal importance, all companies now recognize that they have no choice but to respond to environmental concerns and to adopt a waste minimization attitude.

Federal law requires each company to sign the following certification whenever it ships solid hazardous waste off company property to a storage, treatment, or disposal facility:

> If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; or if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.[1]

All companies which ship waste off-site must periodically report to the EPA their efforts to reduce the volume and toxicity of waste generated and to compare their current volume and toxicity of waste with waste produced in previous years. In addition, some states require that companies which do not ship waste off-site but store or dispose of the waste themselves must submit comparable reports. Thus, the specific

details of waste reduction programs are in the hands of the firms. While these programs are to be under constant supervision of government agencies, many government officials bemoan their inability to confirm the veracity of industry declarations. Waste minimization should become a cornerstone of future environmental protection efforts. If this goal is to be achieved, positive industrial actions must erode the historical attitudes of mistrust within government which currently inhibit a partnership between government and industry to jointly promote and carry out a most attractive concept.

"Waste minimization" as a legal concept was first articulated in law in 1984 although for decades many organizations had tried hard to reduce chemical by-products of their operations. The definition includes any solid or hazardous waste that is generated or is subsequently treated, stored, or discarded. The definition envisaged two complementary approaches: reducing the overall volume of the waste and reducing the concentration of toxic constituents in the waste. Toxicity reduction has usually been given priority and is achieved by a variety of means including chemical treatment and incineration. Volume reduction is generally achieved by modifications in manufacturing processes, changes in raw materials, and recycling and reuse. Sometimes reducing the volume of wastes through, say, sludge thickening or dewatering, increases toxicity, but there is less waste to handle. On the other hand, decreasing toxicity through dilution with soil, for example, means there will be more waste to handle.

The real goal of the 1984 legislation was waste "elimination" whenever possible, elimination that must encompass several categories of wastes: raw materials which are not fully used and also the impurities in raw materials; products which are rejected because they are below specifications; useful and useless by-products; and materials that assist in the manufacturing process but have been changed and are no longer useful such as solvents, acids, and catalysts. Clean manufacturing technologies which eliminate all of these problems are the objective of all industrialists as well as environmentalists. However, there are few if any completely clean manufacturing technologies, and capture and reuse of the wastes become more realistic goals.

While the concept of waste minimization evolved from regulation of solid waste, waste reduction programs should obviously be extended to cutting back the generation of gaseous and liquid pollutants as well.

No longer should industry rely primarily on the removal of these pollutants as they pass through smokestacks or discharge pipes to reduce the chemical burden added to the environment. Reduction of pollution should in the first place become an important consideration in designing new manufacturing processes.

Frequently, but not always, the economic savings from waste minimization programs outweigh the costs of introducing the programs. Savings can result from lower costs of handling wastes, reduced requirements for storage areas, lower transportation and disposal costs, and in some cases reductions in state taxes which are levied on the quantities of wastes that are generated. The Chemical Manufacturers Association notes, "Perhaps the greatest long-term economic incentive for waste minimization is to reduce future liabilities and risk. If a waste is not generated, or is generated in smaller quantities, the risk that it might pose to the generator in terms of involvement in a site cleanup or other legal action may be reduced . . . rule-of-thumb estimates place these savings on the order of $100 to $300 per ton."[2]

Turning this very attractive concept of waste minimization into practical engineering approaches takes many forms. Current engineering practices include changes in the characteristics of products or in the manufacturing technologies; recycling, reuse, or reclamation of wastes or their useful components; and reduction through physical, chemical, or biological treatment of the volume and toxicity of wastes that are nevertheless generated.

A leading environmental engineering firm recently cited a few examples of successful waste reduction efforts. With regard to painting in the aeronautics industry, the Hughes Aircraft Company has adopted new dry powder techniques, Lockheed Corporation has substituted many water-based paints for oil-based mixtures, and at Hill Air Force Base innovative techniques for paint stripping dramatically reduce the liquid wastes. As to recycling, a firm in upstate New York has used settling and cartridge filtration to reuse heat-treating quench oil, and an auto assembly plant in the Midwest recycles hydraulic oils using distillation techniques. An electric power utility regularly recovers valuable vanadium from its wastewater, a printed circuit board facility captures copper that previously was being discharged, and at the Charleston Naval Shipyard, chrome is recovered through vapor recompression.[3]

In short, federal and state regulations have increased both the

difficulty and expense in disposing of hazardous wastes and have increased the incentives for reducing wastes. Some wastes are banned entirely from land disposal. Other waste disposal methods are tightly controlled, and such limitations have led to a shortage of suitable facilities which are approved for receiving chemical wastes. Of course, operations at these facilities are very expensive, and the costs to the companies which have produced the wastes increase every year.

At the same time, generators of unwanted waste often resist mandatory requirements to change their operational procedures in a prescribed manner. They argue: "The government is in no position to tell us about the economic and technological feasibility of introducing changes in our manufacturing and treatment processes which must be customized to individual facilities. We will make appropriate changes as soon as we can." In many respects these industrial arguments make sense. Still, the government must maintain the pressure on industry to ensure that "appropriate" changes are among the highest corporate priorities.

Looking to the future, as companies calculate costs of raw materials and supplies, they will increasingly include the expense of waste disposal as an up-front cost of conducting their businesses. They will seek substitutes which are less toxic. Sloppy housekeeping practices—leaking tanks, loose valves, faulty pumps, spills, and inadequate cleaning of equipment—will not be tolerated as in the past. The flows of wastewater so often laden with chemical pollutants will undoubtedly be reduced. Recovery of waste products will be encouraged on all fronts. Companies have long been eager to recover waste gold from defective electronic circuit boards, but they have now arrived at the point where they may try to recover sandpaper grit from scrap sandpaper.

Industry Reaches Out to the Public

As industrial plants reduce their wastes and tighten their controls on environmental releases of toxic chemicals, their parent companies are becoming increasingly confident that plant managers can successfully reach out into local communities and improve the public image of the safety of their operations. At some point irate citizen groups, as well as governmental agencies, have besieged almost every major industrial facility for polluting local communities. Steel mills and chem-

ical plants were among the earliest targets of citizen anger. Then the public learned that even the supposedly clean electronics industry with few smokestacks was discarding chemicals into the groundwater. Today we know that the many companies working for the government's nuclear defense industry may be the dirtiest of all. Typically, the response of industry to public accusations of irresponsible pollution and to the associated media blitzes had been simply to comply with regulatory orders issued by the government. When necessary, industrial lawyers argued their cases in the courts. Now industry is clearly in a period of transition as it is being forced into a greater degree of openness.

Of course, the EPA requirement for manufacturing facilities to declare publicly the types and quantities of toxic chemicals they release has been an important stimulant for this change in approach. No doubt many firms believe that the best "defense" against greater public outrage is a good "offense." They now spend time trying to convince local communities that releases of chemicals do not necessarily translate into risks to nearby neighborhoods, that toxic discharges are being cut back, and that there are many economic benefits associated with chemical activities.

A series of interviews carried out by a trade association in 1989 with 20 chemical plant managers in Illinois, Louisiana, New Jersey, Pennsylvania, Texas, and West Virginia has provided a checklist for companies in building their corporate image with a skeptical public. The principal conclusions, together with illustrative comments by plant managers, were as follows:

> Run a safe operation. "If you don't have that, community work is a sham and a fraud."
>
> Reduce the quantity of pollutant releases. ". . . the sheer numbers lead them to draw conclusions about adverse health effects."
>
> Coordinate outreach activities with nearby manufacturing facilities. "Facilities are not viewed separately but as an industry. . . . We educated the smaller plants about the requirements of the law."
>
> Present release information early and share it with employees, government officials, citizens, and the media—in that order. "If you can't convince your own employees, you're not going to convince someone out in the public."
>
> Put your release data into perspective. "We found a local filling station that estimates it emits 20,000 pounds of gasoline vapor a year

as people fill their cars with gas. Using that kind of analogy, we give people a better idea of what the numbers mean."

Open the plant doors. "A group of girl scouts came to the plant at 4 A.M. as part of an overnight activity."

Be prepared to answer people's questions at all times, and be responsive to people's concerns as soon as they arise; don't wait for a time that's convenient for you. "As people become more aware of their rights to complain, we get more complaints."

Find out the concerns of the community so that you can decide what kinds of community outreach activities to sponsor. "We have approached these problems in the community as if we're dealing with technical problems, when really the problems are ones of perceptions and feelings."

Get involved in the community and "demystify" the chemical industry. "The first thing I always tell my audiences is that we don't run a candy factory."

Contribute time and money to science education in your local schools. "'Chemophobia' is due to people's ignorance of the chemical industry. . . . I ask kids how, using one word, they would describe the chemical industry. They usually say things like 'ugh,' 'cancer,' 'noise,' and 'destructive.' One time a student said 'helpful' and the other kids in this 10th grade advanced science class booed him out of the room."

Embrace your opponents and those who have the potential to become your opponents. "It's more difficult for people to yell at an individual than at those #$%&* across the street.' "[4]

Sometimes, chemical companies try too hard in their public communications to play down the risks associated with their activities. For example, a recent industry brochure likens one part per trillion (presumably referring to dioxin contamination) to a flea on 360 million elephants, a postage stamp in an area the size of Dallas, and one second in 320 centuries. Understanding the smallness of trace quantities of chemicals is important, but using comparisons based on fleas and elephants can only be seen as an attempt to belittle the significance of serious scientific research efforts.[5]

During the next decade, industrial processes in general, and those of the chemical industry in particular, will become even more transparent to the American public. Companies are becoming well aware of the importance of having an informed public and press. Given the historical suspicions of chemical polluters, many companies are working especially hard to contribute to this educational process.

Industry Braces for Transportation Accidents

Every day tens of thousands of tons of chemicals cross America's highways and railroad lines. Chemicals fill pipelines that connect industrial facilities many miles apart. Still larger quantities of chemicals are constantly moving on barges and tankers along rivers and within coastal ports.

Given the volume of chemicals which are always in our transportation systems, spills from transportation accidents are inevitable. Frequently minor collisions of trucks and temporary derailments of tank cars stir the anxieties of police and fire departments. However, sometimes chemicals moving through populated areas are jolted to a point where they explode or burst into flames threatening local residents and passersby. Once in a while, major accidents in harbors, along rail lines or pipelines, or on roads can cause the evacuation of industrial or residential areas or contaminate waterways and drinking water supplies.

Human error will continue to result in accidents and spills that threaten people and ecological resources. A few railroad engineers, ship captains, and truckers will insist on mixing whiskey and work. Some irresponsible shippers will shortcut maintenance procedures on their vehicles and their equipment. Some haulers will simply become lazy and careless.

But to the American public, the inevitability of human failure simply exacerbates perceived dangers of chemicals threatening communities. Each accident reinforces the public's vision of the flammability, ignitability, and toxicity of chemicals. Many chemical manufacturers are now making major financial commitments to railway and trucking companies to support training and inspection programs which can help reduce the incidence of accidents. However, mishaps on the highways, on the railways, and on the waterways will remain an Achilles' heel of the chemical industry in the eyes of the public regardless of preventive measures of individual companies or of penalties imposed for transportation laxity by government agencies.

The reality of highway and railroad accidents and of human shortcomings in transportation was brought home to me on two occasions during my time at the EPA's Las Vegas laboratory.

In early 1982, the EPA's office in Dallas asked our specialists in Las Vegas to immediately provide aerial photography of a train wreck

in Louisiana. The laboratory was the national center for using aerial photography to assess environmental problems. This wreck resulted in a series of explosions among 37 railcars, including many carrying highly toxic chemicals. Tank cars had been blown for hundreds of feet, and residential areas within a mile of the tracks were being evacuated. The photos of the accident were needed to help position cranes for clearing away the debris even as the fires continued to smolder. According to press accounts, the train's engineer had been drinking beer with his girlfriend in the engine cabin, and he then passed out leaving the control in her hands. She had simply let the train speed along at about 40 miles per hour over a segment of unstable track which collapsed when the speed should have been reduced to 15 miles per hour.

A short time later, I received an evening telephone call from the California Highway Patrol in Barstow, California, advising me that one of the EPA laboratory's small trucks had overturned. The driver was in the hospital, and unidentifiable chemicals from unmarked containers were leaking onto the highway. We immediately dispatched two experts to the scene, and four hours later they had cleaned up the chemical mess. We, as EPA officials, were embarrassed, to say the least. The accident was unavoidable as the truck skidded on a slippery road, but we had no excuse for not properly labeling even very small shipments of chemicals which posed little risk.

Chemical companies are now well prepared for such accidents. They have for a number of years banded together and mobilized their collective expertise to help minimize the damage once an accident occurs.

Often, when an accident happens, confusion reigns as to the characteristics of the chemicals involved. In some cases, as we have just seen, even the identity of the chemicals is unknown. Is the chemical in a pure or diluted form? Should water be sprayed on the spill? How dangerous are the fumes? Can partially damaged containers be moved? What are appropriate cleanup procedures? While the local fire departments on the scene may have handbooks specifying the properties of the chemicals, firemen are naturally very uncomfortable during their initial encounters with strange substances. Generally, the manufacturer of the chemical knows better than anyone else how it will behave and how it should be handled. Local officials are usually eager to receive authoritative advice.

Therefore, 20 years ago, the principal American chemical producers established CHEMTREC as an information service for those responding to emergencies involving chemicals. A central operator through an "800" number provides specific information on the hazards of more than 560,000 chemicals and trade name products. Drawing on an extensive data bank developed in cooperation with all of the major chemical producers, the operator can advise on what to do and what not to do in case of releases, fire, leaks, or human exposure. The operator also immediately notifies the shipper of the chemical who then assumes responsibility for providing further help. More than 5600 companies and organizations rely on this system as their communications center in the event of an accident.[6]

Often the shipper, working with the producer of the chemical, is not able to send an expert to the scene of the accident to provide advice on safe techniques for capping and patching containers, for transferring the chemical from damaged containers, or for dealing with fires or continuing leakage. The distance may be too great and the time too short. Or the producer may be a very small company without available expertise at the moment it is needed. Therefore, the chemical industry has organized 200 industrial teams and about 50 contractor teams throughout the country whose job it is to respond to chemical emergencies. These teams are generally able to provide authoritative advice on any type of chemical spill. This emergency response network is called CHEMNET.[6]

Of course, federal and state agencies also respond to environmental emergencies, and the activities of both CHEMNET and CHEMTREC are supportive of the governmental efforts. These industrial contributions are very important given the technical complexities which often arise in conjunction with chemical accidents.

The Changed Character of American Industry

In the past, most environmental problems were easily identifiable, and in the words of the EPA's first administrator, "You didn't need a scientific panel to tell you that there was a stench in the air, scum on the water, and garbage on the beach." An abundance of readily available pollution control devices led to discernible progress in reducing air and

water pollution. Today the problems of trace levels of toxic pollution are far more subtle and not as easy to correct even though billions of dollars are being spent by industry every year to comply with the ever-tighter regulations to control these chemicals.

For many firms the changes in manufacturing processes that have been necessary for environmental compliance have developed slowly and often implemented with great financial pain. Small firms with limited technical resources and firms with minimal profit margins have had particular difficulties. At the same time, for all companies, the environmental movement has triggered an educational effort to understand the meaning of "risk to the environment" in a chemical age.

Though many political leaders expected that a cooperative coalition between government and industry could be formed to solve pollution problems, they were wrong. The adversarial legal processes that have become the hallmark of today's regulatory systems reign supreme in the environmental field. The EPA and most state environmental agencies emphasize confrontation and not cooperation. Lawyers and lawsuits are the order of the day.

Industry of course has opportunities to participate in the early development of regulations, and at the same time government and not industry should have the final word in deciding the most appropriate approaches to stopping pollution which are then engrained in regulations. However, suggestions of industry are often viewed by governmental officials with suspicion even though the companies may be in a unique position to know which methods of limiting industrial discharges will be the most effective for this end. The EPA and the state environmental agencies need to foster a more cooperative atmosphere. They should give credit to companies that go out of their way to promote environmental protection, and particularly through self-imposed constraints that go beyond the requirements of regulations.

In 1979, about one decade after enactment of the National Environmental Policy Act, *Science* magazine commented on a survey of industrial scientists concerning the rapidly growing responsibilities of the chemical industry to control toxic chemicals as follows: "Attitudes ranged from the view that the chemical industry is in mortal peril to the thought that the present trauma will lead to beneficial results both for society and for the industry. Directors of research contritely admitted past shortcomings in the chemical industry's behavior with respect to its

products. They particularly regretted inadequate consideration of the long-term fate of substances and were unhappy about careless errors of some users of chemicals. They now recognize that if misuse leads to untoward effects, they will share the onus."[7]

Just several years earlier, industrialists vehemently argued that the environmental programs of their suppliers and the safety practices of the purchasers of their chemicals were beyond their spheres of interest. Now in the 1990s they fully understand and accept, perhaps reluctantly, the concept that all of industry must be seized with cradle-to-grave control of toxic chemicals. A company's responsibility for chemicals does not begin when the chemicals arrive at the warehouse and does not end once the chemicals leave the shipping dock.

As we look ahead, the concept of "open-ended" liability will probably be the most important driving force in leading industry to cleaner technologies. The onset of diseases from exposure to chemicals may not begin for 10 to 20 years after people come into contact with the chemicals, and companies must be prepared to deal with claims of delayed effects. Chemicals that leave the plant premises may remain intact for decades, and all the parties that handle a chemical as it seeks a final resting place will share responsibility should harmful incidents occur en route. Furthermore, individual chemicals or mixtures of chemicals in and of themselves may be harmless; however, if combined with other factors such as smoking or poor nutrition, they might indeed become serious health risks. Manufacturers and users of chemicals must be sensitive to such subtleties in their handling of chemicals.

Thus, it is not surprising that many companies now operate safety training programs for the suppliers and customers of their products. Some companies have their own hazardous waste disposal sites to be absolutely sure that "their" chemicals will not become problems due to someone else's negligence. A few companies simply will not sell to anyone, regardless of the financial offer, property that has housed manufacturing operations even though the facilities may have been dismantled. These companies do not want to subject themselves to lawsuits by new landlords who in the next century may claim residual effects from negligence by previous owners. Therefore, they often build fences around these vacated premises and pay all property taxes on the vacant lots for the indefinite future.

Finally, with regard to the public's perception of a company's operations, public interest groups began in the 1970s classifying firms according to their environmental records. They even urged divestitures by stockholders from those companies which had particularly bad records.

Most recently, a coalition of environmental, religious, and investment groups developed the "Valdez Principles." These principles, named after the infamous Exxon supertanker which ran aground off the Alaskan coast while under the command of a negligent skipper, are intended to be a code of conduct for companies. The members of the coalition control over $100 billion of pension and other social funds. They have pledged to avoid investments in companies which do not adhere to these principles. Among the provisions of this code are mandatory commitments to include environmentalists on boards of directors, to commission independent environmental audits of corporate behavior, to provide full disclosure of all environmental incidents, and of course to reduce wastes, improve energy conservation practices, and market only safe products and services.[8]

Meanwhile, the Chemical Manufacturers Association, a major trade association for all of the major chemical companies and many of the smaller ones, has developed its own set of general environmental principles to guide corporate behavior. Compliance with the code is a condition of membership in the association. However, these principles do not include requirements for environmentalists on boards of directors or for independent environmental audits. The areas receiving special emphasis include preparedness to respond to spills and accidents, minimization of wastes, and reduction of environmental discharges of pollutants.[9]

In the eyes of the public, industry has always been at the center of the problem of toxic pollution. Now Americans should recognize more fully than ever before that industry must be at the center of the solution to the problem. While government can impose many requirements on industry to reduce discharges of pollutants and to clean up mistakes of the past, chemicals have become such an integral aspect of modern living that industrial initiatives to complement laws and regulations are essential in striking a balance between economic growth and environmental protection. The companies themselves are usually in the best

position to recognize many aspects of how their products reach the environment and can cause trouble and to develop techniques to thwart environmental problems in the most economical manner.

We should recall the days of World War II when those industrial plants which made outstanding contributions to the war effort were entitled to fly special pennants awarded by the government over their buildings. Now in the war against toxic contamination, those firms which make extraordinary efforts to ensure the cleanliness and safety of their operations beyond the narrow requirements of the law should be similarly recognized in the eyes of the government and the eyes of the public. A few professional societies and environmental journals present awards to individuals, including industrial employees, who make particularly noteworthy technical contributions to environmental protection. Occasionally, local governments and even state governments single out particularly noteworthy environmental programs of industry. This is an encouraging start. But the federal government and most state agencies remain reluctant to pat industry on the back.

America has come a long way in reversing pollution trends by using a long stick on industry, but the time has come for also holding out a tasty carrot—a carrot of public appreciation for responsible industrial behavior.

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