WHY THE POLLUTION PREVENTION REVOLUTION FAILED—AND WHY IT ULTIMATELY WILL SUCCEED

P2 has changed from a revolutionary force to an incremental tool—but future developments may allow the P2 vision to prevail again

Some environmental professionals had a bold vision in the late 1970s and early 1980s. They realized that environmental protection had become nearly totally dependent on a reactive, end-of-pipe way of thinking. The inevitability of industrial wastes and pollutants had become ingrained in people's minds, in government regulations, and in technologies. Environmental protection was equated to pollution control (PC) and waste management.

The bold vision was that a fundamentally different approach was possible and necessary. It would not be based on producing wastes and pollutants in the first place and *then* trying to reduce their harmful impacts. Instead, waste and pollutants would be prevented where they *originated*. This upstream strategy would be a new intellectual framework or paradigm for environmental protection. It was pollution prevention, or P2.

The P2 vision was broad, encompassing changes in manufacturing technologies and practices, chemicals and other raw materials, and even products and packaging. It also covered resource and energy conservation. Could modern technological society really reinvent and restructure itself to work effectively without producing wastes and pollutants? Would it make economic sense? Was there clean technology to do the job? The visionaries soon concluded that the answer to all these questions was an emphatic yes! Admittedly, not *all* wastes and pollutants could be entirely eliminated. But it was feasible to think of a

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massive future change to stop and reverse historic trends of increasing waste generation with increasing industrialization, prosperity, and population growth.

Moreover, traditional PC solutions were not as effective as they seemed. End-of-pipe technology often just shifted wastes or pollutants from one environmental medium to another, such as from air and water pollution control devices that produced concentrated hazardous waste for leaking landfills. It was also getting terribly expensive to safely manage wastes and pollutants and to clean up the toxic residues of the past. This was stiffening industry's opposition to government environmental regulatory programs. The PC paradigm had become counterproductive to fundamental environmental goals and progress.

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As attractive as the P2 strategy was, however, even the visionaries soon realized that any kind of major shift from control to prevention entailed a profound change in thinking—and not merely changes in policy, regulations, and technology. It would require people in virtually every part of society to learn a new paradigm, to cooperate, and to embrace change. Whereas the old PC paradigm rested chiefly with the production side of society in industry, the new paradigm would have to involve the demand side through consumers.

The visionaries talked and wrote incessantly about overcoming obstacles to pollution prevention. They made analogies with preventive health care and its traditionally slow progress. Less visible than the enormous health care industry based on reaction, not prevention, was the expanding billion-dollar pollution control equipment and services industry that would be threatened by the P2 revolution. The environmental industry literally made money from wastes and pollutants. Prevention was a threat to their business. Even environmental organizations quickly became skeptical and concerned about losing the many PC regulatory accomplishments they had fought for. Yet prevention sounded so good. Would people, companies, trade groups, and others actually speak out against prevention? Could they deny that an ounce of innovative environmental prevention was worth a pound of traditional cure?

From the outset, the visionary advocates presented considerable technical information and analysis that made a very positive case for the environmental and economic benefits of the new prevention paradigm. Science did not really dictate harmful environmental wastes. Harmful wastes were not inevitable. Technology actually existed to cut waste generation dramatically. As long as industry could indiscriminately dump its wastes for free and pay no penalty for harming public health and the environment, the out-of-sight/out-of-mind attitude produced no incentives for preventing wastes and pollutants. But times had changed. Environmental wastes represented industrial inefficiency and literally wasted money—industry's money and the public's money. The enormously expensive costs of toxic waste site cleanups, high on the political agenda in the early 1980s, could be reduced in the future through P2.

There was a simple, commonsense attractiveness to prevention. It seemed like a win-win solution, something the loudest grassroots environmental activists, who were always attacking industry, could advocate to make industry environmentally benign. Nevertheless, some 15 years later, it is clear that the revolution has failed. Worse, in many respects, there seem to be few people who remember the vision of a P2 revolution of the past or yearn for it in the future. The original P2 visionaries are mostly gone from the mainstream of environmental activities. The PC believers and P2 incrementalists seem to have won.

But the historic insights of Thomas Kuhn about scientific revolutions apply to the "P2 versus PC"

battle. His concepts are used here to show that the P2 revolution has only been delayed. The pendulum can swing back to a more aggressive approach to P2. There are silent visionaries, persons who have already experienced the "conversion" from PC to P2, who await more environmental professionals to join them.

This article traces how P2 changed from a revolutionary force to an incremental tool—and suggests how the visionaries may yet succeed in the end.

The Early Visionaries

To a large degree, the original P2 visionaries were driven by observations that the political correctness of pollution control was not matched by continued environmental gains some two decades after the environmental movement had emerged. In terms of technology and economics, pollution control and the regulatory system built on it seemed stagnated. What had made sense in the earliest days of environmentalism, as a practical and fast way to address egregious pollution problems, seemed to make less and less sense as time went on. There were too many confrontations over how much pollution was acceptable or safe. There was nothing but opposition by industry to a regulatory system that only increased costs and reduced profits. This translated into confrontation between industry and environmental advocates in the private and public sectors. Pollution control and waste management equipment did not make money for users, only for sellers.

P2 advocates found data showing that some manufacturing companies could produce products profitably but with much smaller amounts of wastes or pollutants than competitors. They then extrapolated, generalized, and theorized that smarter engineers could prevent pollution on a grand scale. But in the early 1980s, the engineering community, especially chemical engineers, reacted badly. Many argued that they had already optimized industrial processes, maximized yields, and reduced wastes. They sometimes said that the P2 advocates were inaccurately portraying the potential for still more waste reduction.

Economically, it also became clear to the P2 advocates that preventing waste and pollution actually reduced costs and created net profits or returns on investments, as many case examples were showing. The people who integrated prevention technology with prevention economics became the visionaries; it was also a necessary step for personal conversion to the P2 paradigm. This was a revolution that made sense, because—in theory—it would be a better environmental solution and it would make much more economic sense to those who traditionally opposed environmentalism.

P2 also offered a way to improve health and safety risks in industrial workplaces, which the end-of- pipe strategy had helped create, by reducing the use of toxic chemicals. Even consumers of many products would face less exposure to toxic chemicals. Why would anyone *want* to purposefully produce waste and pollution? P2 was the right way out of the regulatory system that increasingly both industry and the environmental community said was not working effectively.

Pollution control and waste management equipment did not make money for users, only for sellers.

The early visionaries, affected by their own conversions to the P2 paradigm, preached loudly and with a religious fervor. They gave countless talks at conferences by state agencies, trade groups, and professional societies, and published articles everywhere. They aimed at raising awareness and appreciation of P2 during the early and mid-1980s.

They were a small and diverse group, including people from state government agencies, academia, industry, and a few in the federal government who were trying to shape a national strategy from a great idea. The P2 revolution was conceived by technological optimists, believers in endless human creativity and innovation, with a

Semantic Confusion and Subversion

source reduction toxics use reduction	most P2 integrity
waste reduction waste minimization waste prevention clean technology clean production cleaner production	less P2 integrity
environmentally conscious manufacturing environment by design life-cycle analysis eco-labeling green products industrial ecology industrial metabolism eco-audits environmental audits environmental accounting sustainable growth sustainable design total quality environmental management	high potential for subversion of P2

vision of a zero-pollution industrial society. They focused on the logic of increased efficiency and believed in rational markets in which people with environmental values could be influential. It was as if the mere presentation of compelling information, simple logic, and positive case studies would transform the world. But it rarely has.

One of the important themes often repeated by the early P2 visionaries was learned from industrial case studies. P2 success was linked to individual champions whose commitment to, and passion for, P2 convinced skeptics and overcame organizational obstacles. Similarly, the vocal P2 visionaries who spoke at diverse professional conferences were also champions, causing personal conversions from PC to P2 among scientists and engineers in industry who became champions within their companies. This may have been one of the most important and effective results of the early years of carrying the P2 message to a broad audience.

But one problem was that most new P2 converts were in the environmental departments of industrial organizations and were expected to deal with regulatory compliance. They had little corporate power, were seen as cost rather than profit centers, and faced enormous obstacles in influencing manufacturing. Though such new converts knew firsthand that the PC paradigm needed replacement, they did not have the tools to directly make P2 happen. Their response was, therefore, to act as company champions and convert the army of engineers and managers in mainstream company activities.

After the first intense decade, culminating in the passage of the Pollution Prevention Act of 1990 and many state P2 laws, the spearheaders of the P2 revolution had either burnt out or moved on. They were replaced by a larger number of younger people ready to *implement* P2 and take advantage of the many new opportunities.

But few of the new P2 practitioners seemed to know or care about what the radicals had done before them, and how much energy had been expended in creating those opportunities. Implementers replaced visionaries. Implementers became incrementalists. Vision was replaced by practicality, negotiation, and compromise. Conceptualizers in government were replaced by bureaucrats. Dreamers in industry were replaced by managers. Rapid technological change and progress were replaced by words, newly named programs, and endless new phrases that people invented to feel good and important (see box on "semantic confusion and subversion").

More money was being spent on talking about P2 (and its many semantic equivalents) than on doing it. Unlike the early talk, however, which had a visionary and religious zeal, the new generation of talk was more professional. It was not aimed at converting people from the PC to the P2 paradigm, but instead focused on the mechanics of P2 implementation, with a heavy dose of management and

Quotes from Thomas S. Kuhn's *The Structure of Scientific Revolutions:*

"[T]he transition between competing paradigms cannot be made a step at a time, forced by logic and neutral experience. Like the gestalt switch, it must occur all at once (though not necessarily in an instant) or not at all."

"The transfer of allegiance from paradigm to paradigm is a conversion experience that cannot be forced."

"Rather than a single group conversion, what occurs is an increasing shift in the distribution of professional allegiances."

"[I]f the paradigm is one destined to win its fight, the number and strength of the persuasive arguments in its favor will increase. More scientists will then be converted, and the exploration of the new paradigm will go on."

"A paradigm is what the members of a scientific community share, and, conversely, a scientific community consists of men who share a paradigm."

"To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it can be confronted."

"Paradigms gain their status because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute."

"The proponents of competing paradigms are always at least slightly at cross-purposes. Neither side will grant all the non-empirical assumptions that the other needs in order to make its case. . . . The competition between paradigms is not the sort of battle that can be resolved by proofs."

"A decision between alternative [paradigms] . . . must be based less on past achievement than on future promise."

organizational jargon. The early technological optimism was replaced by an MBA atmosphere. Of course, there were many benefits from such activities. But they also created an incrementalist P2 style, with lowered expectations and little passion.

The Battle against the PC Paradigm

The resistance of the pollution control and waste management industry was understood, at least theoretically, by the early P2 visionaries. But the intensity and ingenuity of this resistance was underestimated. Resistance involved more than just equipment manufacturers and service providers.

Over several decades, a large environmental infrastructure had been established. This consisted of highly influential design, engineering, and consulting companies that were based on the idea of people, expertise, and markets being linked nearly entirely to the end-of-pipe paradigm. It also included a large academic system, as well as even larger state and federal agencies and workforces similarly built on the original paradigm. In truth, environmental engineers really knew little about manufacturing materials and processes in which P2 had to be used—unlike chemical and other engineers that worked directly with the causes of pollution and waste, but who were outside Ωenvironmental programs.

Enormous amounts of physical and human capital had been invested in pollution control and waste management. It could not and would not be quietly or quickly displaced by a new paradigm with new knowledge, new technology, new materials, and new people. Although P2 could not be fought visibly and openly, it could be resisted, challenged, and criticized subtly, indirectly, and subversively.

When a few of the early P2 visionaries started using the word "paradigm," it was because we had

Implications of Kuhn's Ideas for the P2 Revolution

- Belief in the P2 paradigm is not based on unequivocal proof that P2 has all the best answers to all environmental problems.
- P2 solves one major problem better than PC: the fundamental conflict between economics and environmental protection—and the increasing economic inefficiencies of prescriptive regulations.
- The battle between P2 and PC has not been and cannot be resolved by proof. Positive case examples are not proofs.
- Step-at-a-time type incrementalism does not cause sufficient personal conversions from PC to P2. The gestalt switch from PC to P2 is a profound experience of the "light going on." With conversion, the individual is permanently changed. True believers in P2 have a religious, revolutionary fervor that ignites others to see the P2 light. Those converted feel frustrated that colleagues and peers have not experienced the gestalt switch.
- It is the vision of future P2 success and P2 as the basis for a revolutionary change in technological society that is of paramount importance, not past success. Thus, it is correct to speak of "P2 visionaries."
- Many environmental professionals who are not scientists or engineers, such as lawyers and business managers, have not gone through the authentic conversion from the PC to the P2 paradigm. For these nonscientists, P2 is just another approach, seen as complementary to PC rather than as a paradigmatic substitute for it.
- Scientific environmental professionals who have not "seen the light" are prone to give P2 definitions that undermine it and make it little more than a green semantic version of the PC paradigm.
- Most members of the current professional environmental community remain defined by the PC paradigm that they share. True P2 believers are outsiders.
- Even if incrementalists are true P2 believers, they are unlikely to cause others to experience a personal conversion to the P2 paradigm.
- If it is the destiny of the P2 paradigm to succeed, then eventually the greater conversion of individuals to P2, the dying off of PC adherents, and a crisis situation will finally result in the P2 revolution.

been greatly affected by a book of remarkable historic importance: *The Structure of Scientific Revolutions*, by Thomas S. Kuhn (The University of Chicago Press, 1962). Kuhn's ideas about paradigm shifts explained the enormous difficulties and obstacles that always confront a profoundly different way of understanding a specific universe of problems and solutions. Even identifying the change from pollution control to pollution prevention as a paradigm shift or "gestalt switch" for *individuals* was itself an important historic development. Two accompanying boxes set out some key observations from Kuhn's classic book, as well as the important implications these ideas have for understanding the P2 revolution.

To understand the full meaning of a paradigm shift as the basis of a scientific revolution is to better understand not merely why the P2 revolution has failed, but also how eventually it will succeed. The defenders of the old paradigm attempt to preserve it for many reasons, not the least of which is a profound belief that it is correct—and a more subconscious understanding that the defender's quality of life depends on preserving it.

An existing paradigm—by definition—is sustained not merely by thought, but by a real-world infrastructure, or broad professional community, that is totally integrated into society. It was more than PC inertia or PC friction that slowed down P2. It was a PC worldview, a PC language, a PC policy and regulatory system, a PC economy, and a PC belief and educational system.

Opportunities for sustaining, protecting, and preserving the PC system are everywhere. Government environmental initiatives and programs (e.g., environmental technology exports), education programs, industry and trade association programs, and efforts by environmental organizations that

have the potential for advancing P2 could be—and have been—limited, undermined, and coopted by PC interests. Waste management companies have reduced prices to keep business and remove economic incentives for P2. Consulting companies can offer P2 services, but then quickly advise clients to use PC solutions with which they are familiar. Providers of pollution control equipment advertise their products as minimizing or reducing waste.

A remarkable example that persists to this day is the continued attempt to either displace or undermine a tool that early P2 visionaries used convincingly: the waste management hierarchy. The hierarchy is a simple listing of options in descending order of desirability: prevent or reduce, recycle, detoxify through treatment, dispose in a containment facility, or discharge into the environment. A 1983 Office of Technology Assessment (OTA) report entitled *Technologies and Management Strategies for Hazardous Waste Control* gave considerable attention to the hierarchy. The hierarchy was a simple device to communicate the primacy of true prevention over all approaches that addressed wastes and pollutants after they were first generated.

The PC defenders fought against a strict definition of P2 or source control at the top of the hierarchy, wanting instead to include various forms of recycling, sometimes including waste-to-energy incineration. For example, the American Petroleum Institute said that P2 was a "concept that reduces or eliminates pollutant discharges to air, water or land." But these words do not refer to avoiding waste generation in the first place. Instead, they mean that any form of pollution control technology could be used and counted as P2. Integrated waste management, in which all the options fit together, was marketed as a better idea than the hierarchy.

If overt attacks on P2 were too risky, it was sufficient to erode a strong preference for P2—which might become a requirement for P2—and at the very least establish parity between PC and P2. This strategy was supported by PC defenders who argued that the technology was not yet available to implement P2, that P2 would take too long, that it could not be used at existing industrial facilities, and that it could cause entirely new pollution problems.

The PC industry's attack against an authentic definition of P2 continues. For example, in August 1993 the *Journal of the Air and Waste Management Association* (the largest association of environmental scientists and engineers) asked several people to answer the question, "What is Pollution Prevention?" A chair of the association's P2 division (who was an employee of a large environmental services company) said that "the term has yet to come to an exact definition," ignoring a 1990 statutory definition adopted by EPA. Instead, what was deemed better was to let everyone define P2 "on their own terms," with the view that "control technologies and emissions management are all part of balanced, multimedia pollution prevention." The Chair of the American Society for Testing and Materials P2 subcommittee, which represents industry views, said that P2 should include reuse, recycling, and reclamation, and maybe pollution control.

The PC industry's attack against an authentic definition of P2 continues.

Another key historic component of the PC preservation movement was the highly successful effort to emphasize solid waste recycling in a way that would affect virtually everyone in society. P2 was an enormous threat to consumer goods and packaging, not merely to the solid waste disposal industry. P2 visionaries and purists understood the need to maintain a clear distinction between true source reduction and all other alternatives, including most "feel good" recycling.

But recycling received enormous support from many quarters, including people and organizations that were still linked to the PC paradigm at the

deepest levels of thought and understanding. Many environmentalists seemed more concerned about P2 eroding PC regulations and their enforcement than about maximizing true P2. Some environmentalists truly believed that recycling was as good as source reduction, ignoring P2's potential for producing more resource conservation and environmental protection. The environmentalists were joined by less innocent parties who understood that recycling would preserve existing business enterprises in both primary manufacturing and waste management.

Here was a classic case of the good being the enemy of the better. Ubiquitous single-use cameras testify every day that the American throwaway, disposable society has not been replaced by a P2 revolution, but merely colored green. Consumers and environmentalists, as well as manufacturers and waste management companies, can all *feel good* about recycling, while preserving lifestyles, consumerism, and PC regulations and businesses.

Many actions by waste generators were, in effect, sham P2.

Whether collected recyclables would actually be recycled—and not put into landfills or incinerators—was a question that was rarely addressed. A history of recycling facilities becoming Superfund cleanup sites was ignored. Also, whether recycling systems could weather the sharp ups and downs of commodity prices was not examined closely enough.

Waste Generators Stop a P2 Revolution

Despite all the arguments saying businesses could make money using P2, a large segment of industry that generated wastes and pollutants knew from the beginning that a P2 revolution could mean their destruction, especially if the government mandated and regulated it. Industries that produced raw materials which were linked to pollution and waste could, theoretically, be replaced—especially if the toxics use reduction aspect of P2 was successful. Government bans of chemicals (such as PCBs, some pesticides, and CFCs), though infrequent, might evolve into a systematic assault on chemicals, as the Greenpeace campaign against chlorine was illustrating.

Even though manufacturing processes might be replaced by innovative technology to improve efficiency and reduce waste generation, existing facilities had many years of profits left. Capitalization of new plants did not make sense if old ones could still legally and profitably be operated. The chemical and plastics industries in particular felt threatened. Yet these industries could not credibly attack P2, although they often stated that it was being exaggerated, oversold, and made too simplistic.

For several years, industry opposed federal (and often state) P2 legislation, but avoided criticizing P2 publicly. Industry chose another strategy based on turning green without turning to P2. There was "Responsible Care®" in the chemical industry, and a host of corporate green programs and commitments to environmental responsibility and other patriotic good behaviors. The Chemical Manufacturers Association's (CMA's) Pollution Prevention Code includes "practices that address the broader waste management issues beyond source reduction and other waste and release reduction efforts." According to CMA's understanding of P2, it is acceptable to select "a reduction project involving recycle/reuse or treatment."

Many actions by waste generators were, in effect, sham P2. Others were creative ways of disarming, subverting, and misdirecting P2, including these generic methods:

- replacing regulated toxic chemicals by unregulated ones and taking credit for P2 success;
- removing water from wastes and taking credit for huge waste reductions;
- replacing heavy materials in consumer products and packaging with lighter ones;

- obtaining life-cycle data to show that products were really green;
- taking credit for prevention of releases to the environment as if they were equal to prevention of the original generation of wastes and pollutants;
- speaking about corporate P2 commitments and policies while ignoring actual implementation;
- using Toxic Release Inventory (TRI) data to demonstrate P2 even though much of the data described PC actions;
- confusing P2 with total quality management or, better yet, total quality environmental management;
- taking P2 credits for outsourcing or subcontracting (possibly to foreign countries) their most waste-intensive and polluting manufacturing operations;
- diverting public attention away from real P2 by touting corporate green efforts such as planting trees and recycling materials in-house;
- using examples, rather than comprehensive detailed data, to demonstrate progress at the facility or company level; and
- concealing changes in production volumes that accounted for waste reductions.

New words, new programs, and new organizations shifted public attention and political pressure away from P2 to a general greening of industry. Perceptions of major environmental improvement in the name of sustainable economic growth were built and maintained through highly sophisticated and well-funded television advertising campaigns, highly publicized joint projects with environmental organizations, and a whole new era of working with government agencies in a spirit of cooperation and negotiation, replacing sticks with carrots.

Risk assessment and risk management were promoted to blunt P2's attempts to zero out toxic chemicals and pollutants. Everywhere, there were potential economic incentives and new policy instruments, such as tradable pollution rights, which essentially allowed purchasers to buy licenses to pollute. Industry had listened and seen the light. It had stopped the P2 revolution. It had removed the most serious threats to its core operations and products.

A good example of how incrementalism decreases the level of interest in, and respect for, P2 in the manufacturing sector was the keynote address at the 1996 annual meeting of the Air and Waste Management Association. The address, given by the CEO of Eastman Chemical, was entitled "A New Shade of Green." It promoted an "emerging new environmentalism." In the entire speech, neither P2 nor any term associated with it was used. Instead, the "new" approach touted relative risk, the removal of the negative impact of regulations on the economy, and cooperation. Even lip service to P2 was gone. It was a sign of just how much stature P2 has lost, and how far industry goes in talking green while embracing concepts other than P2.

The strategic vision of P2 has been replaced by policy designed to camouflage industry's attack on laws and regulations.

Similarly, an article by the chairman (a former Republican congressman) of the National Environmental Policy Institute in the July/August 1996 issue of *Environmental Solutions* states that the "reinvention" of EPA is aimed at shifting to "innovation, flexibility and cooperation." The goal is "the devolution of authority to the states." Advocates of this approach want more cost-benefit analysis and risk assessment. Here too, neither P2 nor any related term appeared.

The strategic vision of P2 has been replaced by policy designed to camouflage industry's attack on laws and regulations. Rather than attacking P2 directly, the broader approach is to ignore P2 and the need for technological changes in raw materials, industrial processes, and products.

P2 Receives Only Marginal Support from EPA

The early P2 visionaries knew that EPA and the federal environmental regulatory program posed a monumental obstacle to a massive shift in national policy from PC to P2. Some thought that the solution was to focus on new state programs established outside of regulatory agencies and built on the concept of technical assistance and information transfer.

Others (including myself) attempted to work directly on developing a new national policy that would include transforming EPA. It was reasoned that a true paradigm shift or revolution had to be supported by a national consensus vision manifested as explicit national policy. Only federal policy could address the PC regulatory system.

A number of groups conducted policy analyses and published important reports promoting P2 in general, and a strong federal role in particular. But for several years EPA resisted P2, partly due to political appointees in the Reagan administration who supported industry's position, and also because many EPA professional staffers were firmly stuck in the PC paradigm that they had helped institutionalize through regulations.

Although not extensive, the HSWA's statement on P2 had historic significance.

The first federal policy success was realized in the Hazardous and Solid Waste Amendments (HSWA) of 1984. These amendments modified the Resource Conservation and Recovery Act (RCRA), which forms the basis for the hazardous and solid waste programs at EPA. Some congressional staff had been influenced by the 1983 OTA report that placed waste reduction in the context of avoiding problems with hazardous waste landfills and preventing cleanup costs.

Although not extensive, the HSWA's statement on P2 had historic significance because it expanded the objectives and national policy of RCRA to include "minimizing the generation of hazardous waste and the land disposal of hazardous waste by encouraging process substitution, materials recovery, properly conducted recycling and reuse, and treatment." A separate national policy section said:

> The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

The term "waste minimization" was also used, but it covered only hazardous wastes as defined by RCRA. And it included types of recycling and treatment that were not true prevention—a political concession to industry concerns.

In the regulations, a new rule was introduced requiring hazardous waste generators to certify on manifests that they "had a program in place to reduce the volume or quantity and toxicity of . . . waste to the degree determined by the generator to be economically practicable." The problem here was that companies could decide what was economically practicable, and only regulated hazardous wastes were covered. EPA did not have to establish requirements for companies to prove that they had a specific program and had conducted specific analyses.

The waste minimization effort within EPA's RCRA program was small, and represented only a token gesture in the view of P2 visionaries. In an April 1986 article in the *EPA Journal*, the head of the RCRA program commented on HSWA, stating, "it really makes it crystal clear that Congress wants the Agency to move away from land disposal to *other forms of disposal*" (emphasis added). For several years, P2 was contained and constrained at EPA.

EPA also did not take advantage of a provision in the 1986 amendments to the federal Superfund statute requiring states to assure hazardous waste treatment or disposal capacity in the future. The Agency failed to require states to fully account for waste reduction. If EPA had promoted positive assumptions about P2, then the waste management industry would have been sent a signal against building new capacity. Instead, excessive hazardous waste incineration and landfill capacity was built or committed to in the late 1980s, and this created a disincentive for P2 because it lowered the price of disposal.

These various congressional actions, and the later passage of the Pollution Prevention Act of 1990, happened largely because of the commitment of a few congressional staffers and a few members of Congress, most of whom were relatively junior members.

Two reports by OTA played a key role in stimulating and supporting the legislative efforts: *Serious Reduction of Hazardous Waste: For Pollution Prevention and Industrial Efficiency*, released in 1986, and *From Pollution to Prevention*, in 1987. OTA's observation that less than 1 percent of national environmental spending was on prevention, and that some 50 percent of wastes and pollutants could be eliminated with available technology, received remarkable media and political attention.

Many P2 bills were introduced between 1986 and 1989 in the House and Senate. State officials and other advocates of P2 had organized in 1985 as the National Roundtable of State Waste Reduction Programs (now known as the National Pollution Prevention Roundtable), and they were strong supporters of a federal initiative. Appropriations were earmarked for P2 activities at EPA. Representatives from several states that had passed their own P2 legislation lobbied effectively.

But the more powerful members in leadership positions largely ignored or opposed the P2 movement. It took several years to move P2 legislation. The delay was caused by industry's concerns about prescriptive regulatory methods that they believed could cripple U.S. industry, and disagreement over the definition of P2.

For example, in April 1988 the American Petroleum Institute (API) testified in opposition to new P2 laws before a House committee that was considering P2 legislation. In May 1989, API again said, "No new legislation is needed to implement these concepts." Similarly, the Chemical Manufacturers Association, in March 1988, said, "New legislation is not needed to accomplish meaningful waste minimization."

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These concerns were not entirely unfounded. A small number of environmentalists were indeed promoting more prescriptive government requirements in terms of numerical performance or efficiency standards for production operations. For instance, the Natural Resources Defense Council promoted a federally mandated performance standard because it did "not believe that a purely voluntary approach will succeed."

Eventually, P2 supporters prevailed. But the resulting legislation—the Pollution Prevention Act of 1990 (PPA)—was strong on policy statements and weak on requirements for EPA and industry. The term "source reduction" became very important because its definition was carefully crafted in considerable detail and defined by the law. EPA formally said that pollution prevention meant source reduction. It was no accident that pollution prevention itself was not directly defined. Industry succeeded in keeping "pollution prevention" as a larger umbrella term that could be used to include PC actions.

The need to use the term "source reduction," now correctly defined as true prevention and explicitly excluding PC treatment, caused considerable confusion—especially because the terms

"waste reduction" and "waste minimization" had already become established. On the positive side, source reduction was defined comprehensively in terms of waste, pollution, and all environmental media, and—most importantly—it included changes in raw materials and products, not just manufacturing. This was all a defeat for industry, both PC firms and waste generators.

The most onerous regulatory requirement of the PPA was the new reporting imposed on companies that filed under the Toxic Release Inventory (TRI) program, which had been created as part of the Superfund Amendments and Reauthorization Act of 1986. Indeed, the TRI program itself was also an important P2 policy success. It had been championed mostly by environmentalists and some state officials, based on the belief that providing the general public with detailed data on waste generation would build public demand for P2. They were right, and TRI remains an important P2 policy instrument. However, just as long-lasting have been industry's attempts to limit and undermine TRI.

The paradigm shift from PC to P2 was largely thwarted by embedding P2 within EPA's existing PC culture and regulatory system.

The PPA was the key to forcing significant changes within EPA. But internal resistance successfully limited P2 within the bureaucracy, in terms of funding, staffing, and influence.

P2 visionaries believed that a pollution prevention revolution required creating a powerful P2 force within EPA that could challenge and compete with all elements of the PC system. This would require creating a P2 component within the EPA bureaucracy that could openly support P2 and challenge all other EPA activities as being inconsistent with P2—and point out how, in many cases, they provided disincentives for P2. But the attempts to create a separate P2 section with its own assistant administrator failed. Instead, EPA modified the Office of Toxic Substances (which was already the home of the TRI program) to include prevention.

The paradigm shift from PC to P2 was largely thwarted by embedding P2 within EPA's existing PC culture and regulatory system. Agency P2 activities were also fragmented, with centers in the policy office, the RCRA program (both hazardous waste minimization and solid waste recycling), the Office of Research and Development, and the toxics program.

In 1992, EPA issued a memorandum presenting its definition of pollution prevention. While the memo largely cited the PPA's language, it also added some new statements. One was a continuing endorsement of recycling that did not fit the narrowly defined "in-process recycling" that the statute counted as source reduction. The Agency stated, "Recycling that is conducted in an environmentally sound manner shares many of the advantages of prevention—it can reduce the need for treatment or disposal, and conserve energy and resources." EPA added that "drawing an absolute line between prevention and recycling can be difficult." The environmental management hierarchy also was subtly undermined by a statement that it established "a set of preferences, rather than an absolute judgment that prevention is always the most desirable option." According to EPA, preventing pollution and waste was not always the most desirable option. Was the Bush administration's EPA really supporting P2?

About a year later, under the Clinton administration, EPA issued a P2 policy statement that embraced the 1992 definition. It stated, "Environmentally sound recycling shares many of the advantages of prevention. . . ." It also said that feasible "prevention *or* recycling" (emphasis added) should precede treatment and safe disposal. This despite the fact that, in 1989, the National Toxics Campaign had formally petitioned EPA with an excellent analysis of why environmentally sound recycling was not true P2—and was, instead, "a pollution control strategy that causes problems."

The most serious defeat was that EPA never recruited or created true P2 leaders—people who would operate above and beyond the specific federal environmental laws and regulatory programs for air, water, and waste, and, at a national level, to lead, organize, and encourage a P2 revolution. While giving lip service to P2, no EPA Administrator has ever been a true P2 visionary, using the position to articulate the P2 paradigm and build national commitment to it. Instead, energy and focus have shifted to other strategies for addressing the problems with the PC system, such as regulatory reform, cooperation with industry, economic incentives and instruments, risk management, and even global sustainability.

Risk assessment, in particular, has been a corrosive force in the P2 movement because it fundamentally supports the PC strategy, even as industry attempts to use it to limit the scope and impact of the PC regulatory system. Many health risk assessments attempt to define *acceptable* levels of pollutants and wastes, and thereby promote end-of-pipe technology to achieve "safe" levels. Risk assessment has often succeeded in shifting technology and policy debates from prevention to how regulatory approaches based on PC can be better implemented from a risk management perspective. Overlooked is the fact that the best risk management is prevention.

The P2 legislative success in 1990 demonstrated that, as the ancient Greeks said, the peak is the moment of descent. P2 shifted from revolutionary vision to incremental implementation. The new generation of P2 bureaucrats and implementers saw a world of opportunity that they would attack piece by piece.

A significant development was EPA's growing ability to shape national P2 efforts through federal funding of activities that EPA bureaucrats deemed worthwhile. EPA has always been adept at using funding to implement its own agenda and preferences with the academic world and with countless nonprofit organizations. For example, by providing funding for major conferences, EPA was able to control agendas and speakers. By providing funding for organizations, it could assure that its favored activities would be conducted by credible entities and channeled into what EPA deemed important areas. EPA had no desire to let its funding be used in a political or social sense to build and support a true P2 revolution that would conflict with EPA's institutional priorities and goals.

But EPA's P2 power brokers did not share the big vision of the original P2 revolutionaries.

EPA funding has been designed both to institutionalize and incrementalize the expanding P2 movement. In a largely invisible way, EPA's influence took the passion out of the P2 movement and constrained the P2 effort within EPA's own bureaucracy. For a number of years, EPA had been attacked for its lack of vision about and commitment to P2, and now EPA bureaucrats could, through disbursement of money, become P2 powers.

But EPA's P2 power brokers did not share the big vision of the original P2 revolutionaries. The P2 revolution was coopted and undermined by EPA and its money. EPA wanted environmental professionals to be intellectually attracted to P2 without undergoing a personal conversion from the PC to the P2 paradigm.

EPA played an especially large role in funding state programs, which the PPA supported. With respect to these programs, a 1994 General Accounting Office (GAO) report entitled *Pollution Prevention: EPA Should Reexamine the Objectives and Sustainability of State Programs*, stated the following:

> GAO found that many state programs claiming to conduct pollution prevention activities were inordinately involved in waste recycling, treatment, and/or disposal. These programs obtain funding from EPA that rewards their after-the-fact

strategies without looking into whether prevention was possible, which is inconsistent with the policy established by the Pollution Prevention Act.

Many of the 105 state P2 programs identified by GAO were dependent on EPA funding. GAO found that "programs with greater dependence upon EPA funding . . . are less likely to emphasize source reduction." In other words, EPA's misplaced emphasis and the more than $20 million it has given to state P2 programs have sacrificed the purity and primacy of source reduction as envisioned by Congress.

It is this lack of P2 competitiveness at the highest levels of company management that explains the attractiveness of P2 incrementalism.

The lack of an honest focus on source reduction also plagued EPA's 33/50 Program. This voluntary program encouraged industry to reduce releases of certain chemicals, but not necessarily to prevent them at the source.

Information Is Not Action

The post-1990 increases in funding for P2 resulted in new research and development (R&D) efforts, almost always focused on specific industrial sectors and processes. There was a rapid increase in academic programs fueled by both government and industry funding. The historic emphasis on P2 information and technology transfer gained ground.

Case studies of successful P2 projects had always been a mainstay of P2 marketing. As a means to disseminate successful technology, tell compelling stories about corporate possibilities, and encourage government technical assistance programs, case examples seemed logical and irreplaceable.

But history tells a more negative tale. While case studies do provide great illustrations of P2 implementation and can cause a new P2 awareness, their ability to cause concrete P2 investments and adoptions beyond the simplest plucking of the low-hanging fruit is much more problematic. A major limitation is that engineers and managers may accept the facts of a case study, but they rarely believe that all the technical and economic details fit their situation.

There is another inescapable limitation of case examples that is almost always ignored by P2 supporters: P2 may make sense on a microeconomic level, but not at the macro business decision level. Selling P2 on the basis of net economic benefits, as communicated through case examples, ignores the full range of financial and business choices facing senior company managers or owners. There are usually very attractive alternatives to P2, and other ways to increase profits, expand business, or otherwise be successful. Therefore, the competition is not simply between producing waste and having expenses on the one hand, versus cutting waste and increasing profits on the other. The more significant competition takes place completely outside the P2 sphere, where established and more familiar and trusted opportunities compete for investment money and the time of executives.

P2 has always been a bottom-up movement. Although senior corporate executives may embrace P2 for the sake of public relations, within the inner circles of executives and their investors, bankers, and consultants, P2 is not especially competitive. It is this lack of P2 competitiveness at the highest levels of company management that explains the attractiveness of P2 incrementalism, as well as the lack of support for a major P2 revolution. Incremental P2 progress can be accommodated within the existing or preferred systems of companies. It does not require companies to make major decisions to invest significant new capital in new industrial processes and plants, abandon current products, or give up long-term plans based on diversification, expansion of current plants, acquisitions, or selling of corporate assets.

These constraints also explain why state requirements that companies draft P2 plans are not

especially effective. Like so much of P2 data and information collection, these activities add substantial costs and provide opportunities to misinform government and the public—while offering no assurances that comprehensive P2 implementation will occur.

Even when R&D projects and case studies produce positive results, they rarely rise above the limitations that are an inevitable outgrowth of P2 incrementalism. The massive increase in P2 literature is no accurate measure of comprehensive and capital-intensive P2 applications. While it may be true that there has been a marked increase in P2 technology and materials, the historic factors that have always caused a profound underutilization of P2 have not been solved, displaced, or overcome.

Every reason given some 15 years ago for why waste and pollution generators do not fully implement all available, technically feasible, and economically beneficial P2 opportunities generally remains valid. The conferences, talks, and publications on P2 corporate programs and management approaches do not especially reflect actual company investments, nor are they effective in causing companies to move beyond incremental and marginal P2 changes.

The problem with all the P2 information and technology transfer over the past decade is the absence of a cohesive context, a catalytic enhancement, and a powerful platform to launch P2 advances as part of a total P2 paradigm shift. The cumulative and synergistic potentials to make individual P2 accomplishments more effective collectively are unrealized. The existence of many communication pathways is necessary, but not sufficient, for a true P2 revolution. Incremental P2 lacks the coordination and integration of a collective enterprise, defined not by common institutions or professions, but by a common vision.

P2 is fragmented into different professional fields, activities with varying names, multiple government programs, and different applications. As a result, P2 progress remains disconnected and overshadowed by more popular movements. Institutionalized information and technology transfer has not made P2 a transforming force to reshape the industrial economy through changing production and consumerism. Revolutions are not produced by institutions, but by individuals—if they are not blocked by institutions.

Anyone who is familiar with what was said about P2 in the mid-1980s, or who checks the P2 literature of the subsequent decade against the original P2 discourses, will find that virtually every important P2 idea has been articulated previously. Worse yet, the current P2 literature that reflects P2 incrementalism is no different in form or substance from that originally produced. One could reprint reports and articles from a decade ago, and none of the new generation of P2 implementers would know they were not written today. What is especially lacking is a focus on public policy and the broader social implications of P2 that were prevalent years ago. The massive increase in P2 information and technology improvements, in other words, does not reveal a paradigm shift as originally envisioned.

The difficult issue of how best to measure and track P2 progress quantitatively has never been satisfactorily resolved.

Also, the difficult issue of how best to measure and track P2 progress quantitatively has never been satisfactorily resolved. Most attention is given to the TRI data, but these data are sorely inadequate for measuring progress in P2 (at least when P2 is defined as source reduction). In EPA's 1994 *Toxics Release Inventory Public Data Release*, published in June 1996, the following statements appear:

- The PPA data do not allow for an accurate quantification of source reduction.
- A detailed and accurate assessment of source reduction progress requires more detailed information than is included in Form R.

- It is interesting to note that source reduction activities reported by facilities do not appear to be significantly affecting waste generation.
- The reasons for the continued increase in the quantities of TRI chemicals in waste and for the lack of major progress in moving up the waste management hierarchy are not clear.

The problem is that the TRI data probably reflect changes related to use of pollution control and waste management more than source reduction accomplishments. While there are difficult technical problems in developing accurate methods of measuring source reduction at the facility, industry, and national level, the fact remains that it is easy for waste generators to claim credit for various types of reductions that have little to do with source reduction.

Total production-related waste has not decreased because of activities originally hoped for by P2 visionaries.

At a macro level, the TRI data show that, nationally, total production-related waste has not decreased because of activities originally hoped for by P2 visionaries. A true P2 revolution would have been able to produce a downturn in national waste generation, even with an expanding economy, population, and universe of regulated materials. P2 incrementalism has resulted in exactly what we see today.

Disadvantaged by Being Labeled "Environmental"

It cannot be emphasized enough that a key failure of the P2 revolution was its ineffectiveness at translating the fundamental concepts of P2 into nonenvironmental terms and benefits. Although P2 originated within the environmental arena, the early visionaries knew that it had to be defined and implemented in much broader terms, especially as having fundamentally different economics.

P2 could change the style of virtually all technologies and products. It could and should permeate industrial society and the entire economy. It is a way of defining a technological revolution that would provide a different type of industrial society. It provides a fundamentally new attribute with which to judge the quality of virtually everything by moving beyond conventional understandings of performance and economics to include the well-being of the global environment.

Just as preventive medicine has already begun to revolutionize the medical profession, P2 could stimulate and define new ways of understanding and measuring quality and financial performance. Moreover, P2 could resolve the conflict between economic development and environmental protection. Instead of sapping corporate profits, P2 has the potential to increase profits and open up new markets.

Many parts of the private sector saw economic opportunities in P2, either because they could become winners with new products and technologies, or—unfortunately—because they saw a chance to improve their tarnished corporate images while holding on to their traditional technologies, products, and markets. Many smaller, entrepreneurial companies oriented to technology innovation eagerly sought to exploit P2 market opportunities, while larger, established companies with major market shares attempted to retain their place in the market.

Manufacturers of consumer products have become adept at using recyclable materials to maintain products that are or could be threatened by P2. Similarly, the PC industry, including pollution control, waste treatment, and recycling, has been able to maintain markets in large measure because the PC paradigm and regulatory system remain dominant, which makes it difficult or impossible for P2 alternatives to succeed commercially. This has been especially true in the case of exports to global markets, particularly developing countries with rapid rates of industrial expansion.

There have been enough commercial successes for P2 materials, processes, equipment, and consumer

products that the incrementalists can see the glass as half full. But the original P2 visionaries see it as only a fraction full, with enormous potential remaining.

Many large chemical companies have made increasing commitments to PC lines of business, in the form of pollution control equipment and materials, as well as waste management and consulting and engineering services. Therefore, while in theory they could benefit from implementing some P2 within their own chemical manufacturing operations, they have an incentive to limit the P2 revolution. P2 could have potentially negative impacts on their diversification into PC businesses, in addition to undermining traditional markets for chemicals and related products.

Multinational companies and international organizations have eagerly embraced sustainable development as a business strategy. But sustainability has remained a very fuzzy concept. Embedded somewhere within discourses on sustainability is P2. Is P2 merely one of many tools to reach sustainability, or is P2 the best way to define a technological revolution that produces sustainability? Similarly, within business circles, P2 is generally buried within the broader framework of environmental performance. Sustainability has sustained the PC paradigm.

One of the more potent attacks on P2 appeared in a *Harvard Business Review* article called "It's Not Easy Being Green," written by two management consultants and published in the May/June 1994 issue. The authors cleverly used the code phrase "win-win" instead of P2 and did not clearly differentiate between PC and P2. They did not discuss the fact that, by definition, P2 actions produce net profits, unlike PC spending. The authors focused on examples from chemical and petroleum companies—industries that have shown little ability to redefine their business strategies on the basis of P2. These industries see themselves as losing if P2 succeeds.

The authors attacked the idea that P2 offers economic advantages. The solution they desired was improved environmental efficiency—an "envirobabble" term that simply means minimizing spending on traditional PC solutions. Some of the sharpest attacks were the following (the term "win-win" has been replaced by P2 to make clear what the authors were truly attacking):

Sustainability has remained a very fuzzy concept.

- "We do not argue that [P2] situations do not exist; in fact, they do, but they are very rare and will likely be overshadowed by the total cost of a company's environmental program."
- "As environmental challenges become more complex and costs continue to skyrocket, [P2] solutions will become increasingly scarce."
- "By focusing on the laudable but illusory goal of [P2] solutions, corporations and policymakers are setting themselves up for a fall with shareholders and the public at large."

These types of statements were presaged by a 1992 essay called "The Limits of Pollution Prevention," prepared by the Center for the Study of American Business, a conservative think tank. This essay contained the following statements:

- "Pollution may be lessened and it may be treated, but it cannot literally be 'prevented.'"
- "Ultimately, an unbridled pursuit of zero pollution will negatively affect the economy and the environment. . . ."
- "[O]ver-promotion of 'win-win' pollution-prevention rhetoric reinforces the public's illusion that a zero-pollution society is achievable."

In Kuhn's world of paradigm shifts, the above statements would be seen as classic attempts to defend the old paradigm—not with proof or accuracy, but with rhetoric and intentional confusion. These P2 opponents cannot perceive how P2

solutions could replace expensive PC actions. They cannot understand how industry's lack of commitment to P2 is itself a cause of the government's disinterest in shifting its policies from ones that force expensive PC actions to more flexible regulations that allow industry to invest in profitable P2 actions. These P2 opponents do not see pollution prevention as the replacement for PC, but rather as an unaffordable parallel strategy that does not make economic sense.

P2 is the philosophical basis for an industrial and technological revolution.

The Penalties of Incrementalism

The original P2 visionaries acknowledge the P2 achievements of the past decade. But they realize, either openly or subconsciously, that something has been lost. P2 has become contained, institutionalized—just another tool to solve environmental problems.

P2 is more than just a better—or even the best—environmental solution. It is the philosophical basis for an industrial and technological revolution. But P2 has become smothered by the amorphous sustainability movement that industry and leading politicians, such as Vice President Gore, have embraced. The PC industry and the basic manufacturing, energy, and raw materials, industries have been successful in keeping P2 marginalized and incrementalized, happy with the implementers' piecemeal approach.

New paradigms always face serious obstacles from friends and foes alike. Revolutionaries are inevitably confronted by pragmatic supporters who argue for more controlled and limited change—either because that is all they think possible or because it offers less risk of total failure.

Paradigm changes do not necessarily happen incrementally, although they almost certainly take a long time to succeed. Sometimes conditions must change in order to make a new paradigm more readily understood and embraced. In some sense, the old paradigm must fail. The new circumstances can then act as a catalyst, turning a long-dormant alternative into a success. A severe environmental crisis would be such a new condition.

Historically, P2 has been connected mainly to local environmental problems, such as hazardous waste, rather than to global ones. On a local level, a Superfund toxic waste site is a crisis for a community. But much more is needed for a paradigm shift.

Unfortunately, by the time public attention shifted to larger environmental issues, such as global warming, in the 1990s, the P2 movement had already lost much of its momentum. As a result, P2 tends to be ignored when global environmental problems are discussed. Even when the specific actions taken or recommended may be pollution prevention, they are not necessarily explicitly linked to P2, and thus cannot provide support for a larger P2 movement.

This has been the case, for example, with CFCs. Like all chemical bans or sunsetting provisions, substituting new materials for CFCs really was a form of P2, just as using nonchemical substitutes for pesticides has been. Yet these important developments were not defined within a broad P2 strategy or paradigm.

Battles may be won without an understanding of the larger war. Without effective P2 leadership to maintain the passion and increase the scope of the P2 paradigm with demonstrated successes, the old PC paradigm remains dominant. The result is that P2 is underused and does not drive technological innovation and commercial success to its maximum potential. P2 successes are disconnected and incremental. The whole never becomes larger than the sum of its parts. The mutually reinforcing strengths of many P2 successes do not propel the P2 paradigm into dominance.

When opportunities for P2 are lost, they may be lost for a long time. A good example is the global environmental market in developing countries,

where new industrial facilities are being built at a staggering rate. In theory, these countries could leapfrog the industrialized nations by avoiding the PC system, with its inevitable high costs and limited effectiveness, and go more directly into P2. And industrialized countries could benefit by exporting P2 products and technologies rather than traditional PC solutions. But this has not happened.

Instead, the PC industry has largely captured the global environmental market. The PC industry has been driven into the international market partly by significant declines in their home markets—which in turn result partly from incremental P2 successes. There has also been a flattening out of traditional PC markets, resulting from antiregulatory policies and low rates of new plant construction.

Moreover, many established companies in industrialized countries have long benefited from selling old manufacturing equipment to developing countries. Businesses in developing areas, where environmental laws and regulations usually have not yet been enacted, can buy low-cost equipment that does not have to meet regulatory standards. This seems like good economics, but it is shortsighted. In the longer term, they will have to invest in traditional PC equipment, thus increasing their costs.

In addition, the use of new P2 technologies and materials usually offers benefits in terms of product quality that improve competitiveness in global markets. Thus, when they fail to take advantage of P2, companies in developing countries do not maximize their ability to compete with modern plants in industrialized nations. This will become a penalty once their domestic markets cease to have very high growth rates.

A P2 revolution would have resulted in more global near-term uses of pollution prevention. The incremental approach, which hides P2 in the shadows of sustainability, has allowed pollution prevention to be a major missed opportunity for a large part of the planet.

This inevitably leads to much higher levels of pollution in rapidly industrializing countries. Such pollution not only destroys local environmental assets and public health, but eventually affects global problems and people in the industrialized world. Ironically, incrementalism will probably contribute to creating exactly the kind of global environmental crisis that eventually and belatedly will set the right conditions for the paradigm shift from PC to P2. As we used to say in the "old days," P2 very likely will be maximized eventually, but that means all the many benefits of using it sooner rather than later will be lost. For incrementalists, sooner rather than later is replaced by "better late than never."

It is important to note that P2 incrementalism has failed once before.

It is important to note that P2 incrementalism has failed once before. Contrary to popular belief, P2 was not invented around 1980. For more than a decade earlier, people had been talking about it and trying to implement it. There were books on the P2 approach. There were provisions in environmental laws, such as the zero-discharge idea set out in the Clean Water Act and the waste reduction and resource conservation concepts in the RCRA solid waste program. There were also some industrial P2 programs.

But pollution prevention had too many enemies and too many obstacles, and it could not overcome them by a disjointed incremental approach. While P2 existed for many years in various forms, it had not been packaged as a bold new paradigm.

By the early 1980s, the hope was that conditions had changed and that a new, aggressive effort could succeed on a grand scale. P2 visionaries were spurred in large part by the realization that "something was not working right." They believed that a unified strategy encompassing public policy, industrial practices, *all* wastes and pollutants, and the general public could propel P2 forward. That was the vision.

Even if some P2 incrementalists are true believers in P2, they also are unwittingly helping to preserve a PC system and industrial infrastructure that imposes avoidable costs in terms of economic, health, and environmental impacts. These penalties are especially severe in developing countries. Perhaps the incrementalists believe that the organizations and programs they are building are necessary steps to the eventual paradigm shift—that the tortoise will ultimately beat the hare.

P2 visionaries were technological optimists, but they were also pollution pessimists. In some sense, the incrementalists are the opposite, because they are more sanguine about the damage from pollution and more skeptical or cautious about the potential for technological innovation. This may also explain why some activist and grassroots environmental organizations (e.g., Greenpeace, the Citizens Clearinghouse for Hazardous Waste, the National Toxics Campaign, and the U.S. and state PIRGs) were more committed to P2 in its revolutionary form than the more established, conservative organizations (e.g., the Sierra Club, the Audubon Society, and the Environmental Defense Fund).

The P2 revolution has failed because there still are more people and more power on the side of the old PC paradigm.

The P2 revolution appeared especially attractive to communities that were contending with polluting industrial facilities because people living near such facilities personally witnessed the ineffectiveness of end-of-pipe measures. They could see the leaking landfills and polluting incinerators sanctioned by the government regulatory system. Moreover, only P2 offered the promise of improving workplace safety by greatly reducing exposure to toxic chemicals.

Incrementalists in industry and government often have been affected by the need to balance self-preservation against organizational resistance and inertia. An individual who personally "converts" to the P2 paradigm, yet must continue to live and work within the PC paradigm, endures considerable psychological pain and cognitive dissonance. Incrementalists have protected themselves from this problem by avoiding the paradigm conversion.

Nationally, the P2 revolution cannot be advanced primarily through industry leadership. Leadership must come from scientists and engineers in government, in the environmental community, and in nongovernmental organizations. But incrementalism has prevailed in these groups, partly as a result of industry's tactics, which have influenced their thinking.

The result has been that, at a critical time, conversions to the P2 paradigm have stalled. There is no effective national and international leadership focused on P2 in its visionary and revolutionary form. This negatively synergistic nexus of numbing incrementalism and failed leadership has thwarted and delayed the P2 revolution.

Conclusions

Yes, the P2 revolution has failed. But not because of intellectual shortcomings, a lack of technology, or too few benefits. It has failed because there still are more people and more power on the side of the old PC paradigm.

When the window of P2 opportunity opened, a new generation of P2 practitioners rushed in. They have skills, but not passion and vision. They have personal ambition, but not a revolutionary spirit. They are committed to communication, but not to technological innovation. They are mechanics, not strategists and leaders. They fix parts and ignore the whole. It is doubtful that these incrementalists have ever experienced the personal conversion or "gestalt switch" to the P2 paradigm. For them, P2 is intellectually attractive and a career opportunity.

Although P2 is inching forward, it often is disguised and confused with too many other terms. Perversely, this semantic confusion has contributed

to P2's failure to effect revolutionary change. It prevents advocates from presenting a unified, cohesive message and creating a professional environmental community defined in terms of the P2 paradigm. The semantic differences have caused fragmentation and inefficiency, and have prevented P2 from reaching critical mass. The desire to invent new terms evidences a lack of personal P2 conversion and vision. Or perhaps it reflects the belief that, if only the right words could be found, more would happen.

To measure whether the P2 revolution is moving forward, it is necessary to know the extent to which members of the scientific environmental community have experienced the P2 paradigm conversion. What seems very clear is that incremental P2 implementation does not cause widespread individual P2 conversions. What united the original P2 visionaries in the 1980s was their shared conversion from the PC to the P2 paradigm, and it made them a potent force. Widespread shared conversions are absent in the cold incremental world of P2 that has fallen victim to both the PC paradigm *and itself.*

But if Kuhn was right, the P2 revolution has only been delayed, because P2 is more than just a better environmental solution. Pollution prevention defines a style of preferable technology. To be a P2 revolutionary is not to be antitechnology. P2 technology has quality and sustainability because, whatever else it does, it does no harm to human health and the planet's ecology.

It has often been said that technology is neither good nor bad, that it all depends on how the human race uses technology. But this simplistic view is incorrect. Any technology that intrinsically causes harm, regardless of how it is used, is bad technology. Technology that pollutes is bad, and this does not change simply because pollution control technology is used to mitigate its pollution impacts.

Using pollution control only leads to a chain of technology whose promise of environmental protection is unreliable and deceptive. More often than not, such control technology merely displaces pollution in space and time—to developing nations, to poor people in industrialized countries, and to future generations. Only the P2 paradigm can truly offer environmental justice. Pollution control technology is doubly bad: It not only creates pollution itself, it seduces society into using other polluting technologies.

Pollution prevention is truly a scientific paradigm, because it attacks the dominant view of technology that ignores pollution's impacts and uses pollution control to make inferior technology socially acceptable. By contrast, pollution prevention does not deceive.

The P2 revolution is not merely about environmental protection. It is about the search for benign technology. When one undergoes a personal "P2 conversion," the light that comes on illuminates a vision of things to come. It is a vision of a revolutionary technology that is brilliantly nonpolluting.

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