

TEXAS

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Pollution Prevention: A Paradigm Shift in Environmental Management

In recent years, there has been a paradigm shift in the way many industries approach environmental management issues. At the heart of this new approach is the idea that pollution is waste and that its prevention may have economic as well as environmental benefits. In the long run it is more efficient to eliminate waste from the production process than to spend large amounts of money to clean up after it has been created. Eliminating waste at the source, or source reduction, involves goal setting aimed at minimizing the environmental impact of a firm's operations.

Traditionally, rigid environmental regulation has shaped the way firms addressed environmental issues. The old environmental management approach was to allocate resources towards compliance with regulation in order to avoid litigation and a negative public image. Both regulators and firms focused on end-of-the-pipe solutions, or pollution control. These firms and regulators are now turning their attention to restructuring production processes such that waste is reduced or eliminated. Here we discuss the main reasons for this paradigm shift and the incentives for firms to adopt the new approach.

The Proactive Approach

Firms that adopt a strategy of pollution prevention regard environmental compatibility as a goal incorporated into the strategic plan. Many firms reexamine all stages of their product life cycles rather than isolated segments of the cycles. This cradle-to-grave method looks at resource extraction, materials processing, manufacturing, use, and waste management (see figure). Involved is

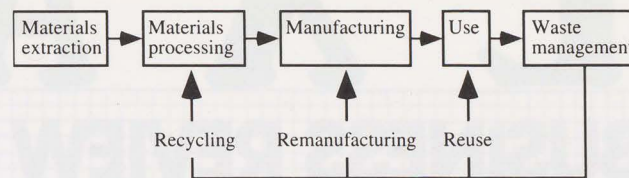
the examination of the environmental, safety, and health impacts of the product at each stage and minimization or elimination of waste streams through redesign of products and processes, substitution of materials, redefinition of relationships with suppliers, and changes in waste disposal practices. Inside this framework, engineers are focusing on "design for the environment," which promotes designs for products that are energy efficient and easy to disassemble and recycle.

In recent years, environmental agencies have recognized the need for flexible regulation with incentives for pollution prevention. Flexible and market-based policy instruments are favored more than command-and-control methods. In addition, the regulatory agencies have recognized that many firms, especially small firms, need information about new pollution prevention technologies, markets for recycled products, and toxicity of materials.

Information and technical assistance are integral parts of more flexible regulation. This helps firms adopt the most cost effective technologies and methods appropriate to their activities in meeting government environmental goals. In 1986 the Emergency Planning and Community Right-to-Know Act was enacted by Congress. It requires that large manufacturers report releases of over 300 toxic chemicals annually to the Environmental Protection Agency (EPA), which releases the information to the public as the Toxic Release Inventory (TRI). The TRI has served as an organizational framework for both firms and regulators.

The passage of the Pollution Prevention Act of 1990 made it national policy to reduce or eliminate the generation of waste at the source. This changed the focus of regulation from pollution control to pollution prevention. The act also required firms to report their recycling, energy

Figure
Stages of the Product Life Cycle



Source: Adapted from U.S. Congress, Office of Technology Assessment,
Green Product by Design: Choices for a Clean Environment,
October 1992, p. 4.

recovery, or source reduction activities as part of the Toxic Release Inventory.

The state of Texas has also adopted pollution prevention as its regulatory priority. In 1991, the Texas legislature passed Senate Bill 1099, the Waste Reduction Policy Act, which required that all sites having to file a TRI must also prepare and file a pollution prevention plan with the Texas Natural Resources Conservation Commission (TNRCC). Firms must follow up with an annual progress report. The TNRCC is committed to achieving goals of pollution prevention through partnerships between regulators and businesses. One program run by TNRCC is called Clean Industries 2000. Participation is voluntary, however membership requires that firms commit to reducing toxic releases tracked by the TRI by 50 percent between 1987 and the year 2000. Over 130 facilities in Texas are currently enrolled.

Incentives for Change

Various factors motivate firms to become environmentally conscious and invest the time and resources necessary to adopt pollution prevention strategies. These include waste minimization and cost savings, long-run global or national competitiveness, and environmental stewardship inspired by corporate concern for public image and consumer support for resource conservation.

Waste minimization and cost savings

Cost savings is a powerful motivating factor for undertaking pollution prevention projects.¹ The principal motivation for many recycling, waste minimization, and energy conservation projects is reduced environmental impact combined with immediate net cost reductions. A leader in proactive environmental management since 1975, 3M established channels through which employees could recommend projects that would reduce both costs and the environmental

impact of the company's operations. This program, called Pollution Prevention Pays (PPP), has resulted in more than 4,100 pollution prevention projects, a reduction of more than 1.3 billion pounds of waste, and savings of \$710 million during the last two decades. A program introduced by Compaq Computer Corporation emphasizes energy conservation measures for its facilities. Compaq uses solar powered street lights and a building design that maximizes the use of natural light to improve energy efficiency. In Houston in 1992 alone, Compaq reduced energy consumption by 9 percent, which could be translated to an average reduction of about 9.3 million pounds of carbon dioxide and 17,000 pounds of sulfur dioxide emissions from the power plant serving this location.²

Most environmental regulations have focused on end-of-pipe issues and have forced industry to dispose of waste instead of pursuing pollution prevention options. This type of regulation left little room for innovation and cost reduction. The Pollution Prevention Act was one of the first pieces of legislation to allow industry to consider waste reduction as a source of cost savings and environmental protection. Motorola's Oak Hill facility in Austin, Texas, used to deepwell inject its sulfuric acid in compliance with acceptable regulatory disposal methods. Recently they have begun reselling the acid as a product to other companies. By exploring and using pollution prevention options, Motorola has eliminated waste sulfuric acid disposal costs, protected the environment, reduced liability, and made useless waste into a useful product. In the near future, the Oak Hill facility will adopt a new technology to reprocess the sulfuric acid on-site for reuse in internal production.

Competitiveness

The elimination of waste streams generally requires an investment in research and develop-

ment that will yield improved technology. Michael Porter of the Harvard Business School has argued that strict environmental regulations have triggered innovations that enhance competitiveness. He mentions the case of Germany, which has the world's strictest regulation for stationary air pollution control. German companies hold many patents in pollution control technology and export this technology to other countries.³ While the evidence that regulation stimulates innovation and enhances competitiveness is far from conclusive,⁴ it is likely that an important economic benefit of investments in source reduction technology is the ability to stay in business in a world that increasingly values sustainable activities. In the long run, clean industries have efficient and cost effective processes that allow them to remain competitive in the global market.

Competitiveness is influenced by regulation in both domestic and export markets. Germany has already passed legislation that requires firms to take back their products when consumers are ready to discard them. Firms wishing to export to lucrative German markets are being forced to reexamine issues of packaging and disassembly.

Continued economic expansion and population growth will increasingly lead to exhaustion of nonrenewable natural resources, increases in air and water pollution, and an overload of landfills from household and industrial solid waste. As this happens, global demand for environmentally friendly products will likely increase. Consumers valuing environmentally benign products and green manufacturing will be willing to pay a premium for these products and services. Competitive advantage and market share will increasingly belong to companies and nations that develop and use green technologies. Many firms recognize that it is in the interest of long-term competitiveness to invest in improved technology now and eliminate the need for investment in waste management in the future.

Environmental stewardship

Many firms have made aggressive and innovative environmental management part of their corporate philosophy. These firms view minimizing environmental impact both as responsible corporate behavior and as a means of perfecting their product. Fifteen percent of 3M's research and development spending, approximately \$150 million annually, is devoted to reducing the

environmental impact of new and existing products and improving manufacturing processes. As an example, 3M currently has a goal of reducing all releases to air, land, and water by 90 percent from 1990 to the year 2000. The long range corporate strategy is to eliminate all solvents from production. In 1989 Compaq set a goal of completely eliminating chlorofluorocarbons (CFCs) from operations by 1995; the company achieved this goal two years early. Motorola fosters a proactive approach to pollution prevention through environmental awareness training and by sponsoring an environmental awareness award for innovative ideas.

Summary

A proactive pollution prevention approach is a dynamic and evolving process that requires executive commitment, management leadership, employee involvement and teamwork, and the willingness to explore and implement new ideas. Such an approach brings challenges and opportunities to a company. Bruce Smart from World Resource Institute observes that while environmental issues present expensive and ambiguous challenges to managers, so does any facet of management, including anticipating markets, technology, or social trends. Although pollution prevention does lead to short-run cost savings in some cases, larger environmental issues require large investments and the economic payoff will be the right to stay in business.⁵

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Notes

1. In January 1994, the Natural Resources Program of the Bureau of Business Research conducted a survey of selected high tech electronic firms in Texas regarding their pollution prevention activities. Any specific firm information provided in this article is based on company responses.
2. Compaq, *Environmental Report 1992-1993*, p. 5.
3. Michael Porter, "America's Green Industry," *Scientific American*, April 1991, p. 168.
4. Adam B. Jaffee, Steven R. Peterson, Paul R. Portney, and Robert Stavins, "Environmental Regulation and the Competitiveness of U.S. Manufacturing," *Journal of Economic Literature*, March 1995.
5. "The Challenge of Going Green," *Harvard Business Review*, July/August 1994, p. 42.

Exporters by Industry

The extent to which Texas manufacturers participate in global markets varies considerably depending on the types of goods they produce. Some industries, such as food processing, furniture, and printing, have traditionally expanded to satisfy domestic markets and relatively few plants export. Others, including scientific instruments, computers, chemicals, and transportation equipment, demonstrate a higher likelihood to sell their products worldwide (see table).

Overall, Texas plants engaged primarily in the manufacture of high-tech and oilfield-related products (scientific instruments, electronic equipment and components, and industrial machinery and computers) tend to export with greater frequency than other industrial sectors. The directory database includes listings for 5,192 plants in these three largely high-tech sectors, and 37.2 percent of them report having an international distribution. Most of the exporting plants in these three sectors are located in the metropolitan areas of Houston, Dallas, Ft. Worth-Arlington, and Austin.

Texas plants involved in the manufacture of chemicals and allied products also demonstrate a greater tendency to export than the state average for all plants. The *Directory of Texas Manufacturers* indicates that over one-third of the state's chemical manufacturers, or 421 plants, export their products. Of those that export, one out of three is located in the Houston metropolitan area. The international orientation of the Texas chemical industry is underscored by its inextricable link to foreign investment—the chemical industry represents one-quarter of all cumulative foreign direct investment in Texas.

Despite the high value of exports from the Texas transportation equipment sector (\$6.6 billion in 1994), there are surprisingly few manufacturing plants that export such goods, indicating that Texas shipments in this sector are coming from a relatively small number of large manufacturing establishments (primarily aircraft and automotive). Exporting plants in the transportation equipment industry are concentrated in Dallas, San Antonio, and particularly Fort Worth-Arlington—three areas with notable agglomerations of aircraft- and motor vehicle-related employment. These three metropolitan areas account

Table
Exporting Manufacturing Plants in Texas
by Industry

(Ranked as a Percentage of Total)

Rank	SIC-Industry	Number of plants*	Number exporting	Exporters as % of total
1	38—Scientific instruments	875	370	42.3%
2	36—Electronic equip. & components	1,162	451	38.8%
3	28—Chemicals & allied products	1,192	421	35.3%
4	35—Machinery & computers	3,155	1,110	35.2%
5	33—Primary metal industries	422	139	32.9%
6	37—Transportation equipment	655	189	28.9%
7	29—Petroleum refining	229	66	28.8%
8	30—Rubber & misc. plastics	1,269	363	28.6%
9	34—Fabricated metal products	2,981	732	24.6%
10	22—Textile mill products	116	27	23.3%
11	31—Leather & leather products	193	42	21.8%
12	26—Paper & allied products	478	89	18.6%
13	23—Apparel	887	148	16.7%
14	39—Misc. manufacturing industries	1,254	168	13.4%
15	24—Lumber & wood products	902	102	11.3%
15	32—Stone, clay, glass, & concrete	1,185	134	11.3%
17	20—Food & kindred products	1,102	122	11.1%
18	25—Furniture & fixtures	737	80	10.9%
19	27—Printing & allied industries	2,780	231	8.3%
20	13—Products from natural gas	196	6	3.1%
—	21—Tobacco products	2	0	
Grand total		16,663	3,673	22.0%

* Industry totals do not add to grand total because many plants are involved in more than one major group.

Source: 1995 *Directory of Texas Manufacturers* (Austin: Bureau of Business Research, 1995). (Calculated by the Texas Department of Commerce's Research & Information Group from data collected by the Bureau of Business Research at the University of Texas at Austin.)

for half of Texas' exporting plants in the transportation equipment sector.

Information about specific companies listed in the *Directory of Texas Manufacturers* can be obtained by contacting the Bureau of Business Research at 512/471-1616. The 1995 edition of the *Directory of Texas Manufacturers* was released in March.

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Texas Manufacturing Plants That Export

In 1994, Texas merchandise exports grew 15 percent from the previous year to nearly \$60 billion, with manufactured goods making up 94 percent of the total. The state's merchandise exports in 1994 represented almost 12 percent of total U.S. shipments abroad and 13 percent of Texas' gross state product.

Clearly, exports make a substantial impact on the state economy, but scant data are available for manufactured exports below the state level. One exception is the information offered by the *Directory of Texas Manufacturers* published by the Bureau of Business Research. Using data from the 1995 edition of the directory, this article analyzes characteristics of Texas plants that export, including employment size, geographic concentration, and industrial composition. Of the 16,663 manufacturers included in the directory, some 3,673 plants—22 percent of the total—report having an international distribution for their products.

The Bureau of Business Research at UT's Graduate School of Business has conducted surveys of manufacturers and produced the annual *Directory of Texas Manufacturers* since 1933. Texas companies voluntarily provide their names, addresses, product descriptions, and other information for inclusion in the publication. On the questionnaire, the bureau asks its respondents to indicate the widest known geographical extent of their product distribution, using one of three categories: state, national, or international. The directory provides a unique opportunity to analyze the state's exporting plants based on voluntarily reported data.

Exporters by Employment Level

The likelihood of export activity correlates strongly with employment size—the larger a plant's employment, the more likely it is to export. According to the directory, only 18 percent of small Texas plants (those with fewer than 50 employees) export. By contrast, 38 percent of plants employing between 50 and 499 people and 54 percent of establishments with 500 or more employees export. A comparison of the 1995 directory with the previous year's edition indicates that both small- and medium-sized manu-


facturing plants are expanding their distributions to foreign markets. In the 1995 edition, exporters accounted for 18 percent of small Texas plants, up from 16 percent the previous year. International distribution by medium-sized plants grew from 35 to 38 percent during the same period.

Exporters by Geographical Location

Manufacturing plants that export are heavily concentrated in the state's five largest metropolitan areas: Houston, Dallas, Fort Worth-Arlington, San Antonio, and Austin. Combined, these five metropolitan areas have 2,548 exporting plants—nearly 70 percent of the state's total. Houston clearly stands out with both the largest number as well as the highest percentage of manufacturing plants that export. With more than one thousand establishments exporting, the Houston metropolitan area is home to well over one-quarter of all the exporting plants listed in the directory.

With exports from Texas to Mexico reaching nearly \$24 billion in 1994, it is not surprising that manufacturing plants situated close to the Mexican border demonstrate a strong tendency to export. The plants located in Texas' border metropolitan areas—Brownsville-Harlingen-San Benito, McAllen-Edinburg-Mission, Laredo, and El Paso—are more likely to export than those found in most other metropolitan areas in Texas. The border metros rank among the top ten in Texas based on the percentage of manufacturing plants that export.

Nine out of ten Texas manufacturing plants that export are located in metropolitan counties. The remaining 10 percent, some 366 plants, are in nonmetropolitan areas. According to the directory listings, nonmetropolitan manufacturers are significantly less likely to export than their urban counterparts. Only 14.2 percent of rural manufacturers in Texas ship their products to foreign countries, compared to 23.5 percent for metropolitan areas. One anomaly is the leather industry, which represents a relative strength for nonmetropolitan areas in Texas. Some 32 percent of the leather products manufacturers located in nonmetropolitan areas have an international product distribution—considerably higher than the 18.9 percent of urban plants in this industry that export. Over two-fifths of Texas' exporting plants in the leather industry are located in nonmetropolitan areas.



Announcements

The **1995 Directory of Texas Manufacturers** and **Texas Industrial Expansion** are available as a package for \$130 plus tax for Texas residents, or **Texas Industrial Expansion** may be purchased separately. Both publications are available in electronic format. To order by phone, call (512) 471-5179; by fax, (512) 471-1063.

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