

THE ENVIRONMENT AND THE HIGH-PERFORMANCE REVOLUTION

Final Report to the Great Lakes Protection Fund



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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	3
PROJECT ACTIVITIES	3
Initial Identification of Supplier-Based Pollution Prevention Efforts	3
Corporate Environmental Best-Practices Survey	4
Case Studies of Best-Practice Supplier Management	5
Dissemination Activities	5
THE ENVIRONMENT AND THE HIGH-PERFORMANCE REVOLUTION	7
Total Quality Environmental Management	7
Zero Emission Manufacturing	7
Worker Involvements and Continuous Improvement	8
Pollution Prevention through Process Modernization	8
Green Design	10
SUPPLY CHAIN MANAGEMENT AND POLLUTION PREVENTION	12
Best-Practice Approaches to Supply Chain Management	14
IBM: Working with Suppliers	14
Ray-O-Vac: High-Performance Pollution Prevention	15
Safety Clean: Working Backward and Forward across the Supply Chain	15
Quad/Graphics" Cost Savings via Environmental Strategy	15
Amko Plastics: Suppliers and Sustainable Manufacturing	16
Sony: Leveraging High-Performance for Environmental Improvement	16
HARNESSING THE HIGH PERFORMANCE REVOLUTION FOR THE ENVIRONMENT	17
Strategic Directions	18
Acknowledgments	21
Appendix I Project Advisory Board	22
Appendix II Company Interview and Contacts	22
Appendix III Agency Contacts and Contact Information	26

EXECUTIVE SUMMARY

The Great Lakes region is recognized internationally for the restoration of its five Great Lakes and for its remarkable transformation from *rustbelt* to a heartland of high-performance manufacturing.

The Environment and the High-Performance Revolution outlines the potential for the Great Lakes region - and the Great Lakes basin in particular - to gain environmental benefits from ongoing corporate efforts to improve industrial competitiveness. It examines the efforts of leading manufacturing corporations to simultaneously increase productivity, reduce emissions and wastes, and improve their environmental records. And, it focuses on the ways that innovative partnerships between corporations and their suppliers can be used to accelerate pollution prevention, reduce toxic emissions, and improve the overall environmental quality of the Great Lakes basin.

This study is based on a national survey of corporate environmental best-practices, and detailed case studies of leading high-performance manufacturing firms in the Great Lakes region and basin.

Findings: The three main findings of the study are as follows:

- Corporate environmental efforts are increasingly tied to broader efforts to improve competitiveness through the use of high-performance manufacturing strategies. Manufacturing firms are leveraging industrial modernization to achieve environmental improvement. Companies increasingly prefer innovative approaches to production process improvement which improve productivity and environmental performance simultaneously over traditional treatment and end-of-the-pipe remedies. Pollution prevention and green design have become defining features of high-performance manufacturing.
- Industrial performance is an increasingly important engine behind corporate efforts to prevent pollution and improve environmental quality. While firms continue to be motivated both by regulations and corporate citizenship, environmental strategy is increasingly motivated by

deeper and more fundamental corporate drives to improve productivity, capitalize on new technology, and serve key customers.

- Growing partnerships between end-users and suppliers to improve productivity and implement high-performance manufacturing open up new and promising pathways for regional and basin-wide environmental improvement. Manufacturing firms in the Great Lakes region and basin involve their suppliers in a variety of pollution prevention activities and increasingly use supply chain management to improve their overall economic and environmental performance. The biggest payoffs from supply chain management stem from ongoing joint efforts to improve productivity, eliminate defects, and reduce costs, rather than from direct efforts to transfer pollution prevention technology or organizational strategies designed expressly to eliminate toxins or prevent pollution.

Strategic Directions and Policy Recommendations:

Regional policy-makers can accelerate this transformation by acting on the following six points:

- **Link the Region's Environment and Competitiveness Agendas:** Government policy, at the regional, state and local level, as well as at the federal level, must overcome the fragmentation between environmental and economic development program areas and increasingly act to spur and motivate the deeper process of high-performance economic transformation. Environmental considerations should be integrated into all regional efforts to move to high-performance production and in related workforce development agendas. The objective and mission of government policy must be to **simultaneously improve economic and environmental performance.**
- **Let High-Performance Firms Lead:** High-performance manufacturers are the engines of this industrial-environmental revolution. The region should find mechanisms to involve the CEOs of leading high-performance corporations and other experts in providing strategic direction and advice on how to link the region's environmental and competitiveness strategies.

- **Political Leadership:** Strong, consistent and unswerving political leadership is required to ensure the move to a high-performance economic and environmental agenda. The governors of the Great Lakes' states have long set the tenor for the nation with their leadership on environmental, competitiveness, and most recently with their pioneering welfare reform initiatives. The political leadership of the Great Lakes basin and region must make the integration of environmental and competitiveness agendas and the pursuit of a high-performance economy a top priority.

- **Develop a High-Performance Policy Framework:** The high-performance revolution demands a new policy framework — one that is attuned to the needs and demands of high-performance manufacturers. The existing environmental policy framework, which grew up during the age of mass production industry, functions as an impediment to further economic and environmental revitalization. The following are principles which can guide state, regional, and basin-wide efforts to develop that new framework.

1. Make Policy Meet a High-Performance Test
2. Establish Cross-Agency Economic-Environmental Policy Teams
3. Establish New Benchmarks for Measuring Progress
4. Extend the High-performance Revolution through Redevelopment of Brownfield Sites: The individual Great Lakes states, the Council of Great Lakes' Governors, and the Great Lakes Protection Fund should make redeveloping older sites into centers of high-performance production a top priority of their agendas.

- **Establish a Multi-Stakeholder Process to Ensure Success:** The Great Lakes' Governors should establish a **Great Lakes High-Performance Environmental Initiative** - a multi-stakeholder initiative - composed of leading high-performance business, environmental, policy, civic and academic experts to set this process in motion.

- **Role of the Great Lakes' Protection Fund:** The Great Lakes Protection Fund has played a vital and essential role in the environmental renewal of the Great Lakes basin. The Fund can continue to fulfill its historic mission and can also play a central role connecting the economic and environmental revival of the Great Lakes basin and region. To do so, it should consider devoting a significant share of its actions to playing the role of *venture capitalist* in the transformation - providing equity funds that will "*pay-back*" on investments by stimulating the transition to economic and environmental renewal. The Fund can also play a role by supporting the monitoring, analysis and timely evaluation of the costs and benefits of this process and convening key stakeholder groups to constructively debate and reach consensus on strategies and actions.

The high-performance revolution can - and is - being leveraged for environmental ends. The efforts of firms to improve manufacturing processes and increase productivity are opening up new opportunities for environmental improvement in the Great Lakes region and basin. The adoption of high-performance manufacturing, which has helped to revitalize the region's manufacturing base, is now creating powerful incentives and opportunities for pollution prevention and environmental improvement. The region's growing base of highly innovative, high-performance firms are leaders in the race to improve productivity and reduce environmental costs and risks.

The high-performance revolution is ushering in a new paradigm for regional growth and development. The pursuit of zero defect and zero inventory manufacturing strategies is creating considerable environmental benefits as well, leading toward zero emission manufacturing strategies.

The Great Lakes region is on the cusp of this new high-performance paradigm revolving around zero defects, zero inventory, and zero emissions. By linking the region's environmental strategy to its high-performance competitiveness agenda, the Great Lakes can continue to improve its environmental quality, while strengthening its manufacturing base and securing long-run economic growth for its workers, citizens, and communities.

INTRODUCTION

The Great Lakes region is recognized internationally for the restoration of its five Great Lakes and for its remarkable transformation from *rustbelt* to a heartland of high-performance manufacturing.

Environmental regulations have, unfortunately, not kept up with this process of economic transformation and may, in fact, constitute an impediment to further economic transformation and revival. Traditional command-and-control approaches to environmental regulations have often resulted in corporations putting their capital in costly end-of-the-pipe control technologies and furthermore in shifting pollution down the supplier chain, as large firms reduce compliance costs by transferring toxic generating stages of production to suppliers that are often less effectively monitored and lack the internal capabilities for control and prevention.

There is, however, expanding national, regional and basin-wide interest in innovative approaches to pollution prevention, particularly those which leverage innovative manufacturing strategies. The Great Lakes region contains a growing base of high-performance manufacturing firms that see their suppliers as a source of competitive advantage. They do so by working with their suppliers to reduce costs and improve quality by implementing innovative high-performance manufacturing strategies.

The Environment and the High-Performance Revolution outlines the potential for the Great Lakes region - and the Great Lakes basin in particular - to gain environmental benefits from ongoing corporate efforts to improve industrial competitiveness. It examines the efforts of leading manufacturing corporations to simultaneously increase productivity, reduce emissions and wastes, and improve their environmental record. It focuses on the ways that innovative partnerships between corporations and their suppliers can be used to accelerate pollution prevention, reduce toxic emissions, and improve the overall environmental quality of the Great Lakes basin.

PROJECT ACTIVITIES

This study is based on a national survey of corporate environmental best-practices, and detailed case studies of leading high-performance manufacturing firms in the Great Lakes region. The project included the following activities.

Initial Identification of Supplier-Based Pollution Prevention Efforts: We began by contacting more recognized organizations and experts and asking them to provide lists of firms in the Great Lakes Basin that were using innovative programs to involve their suppliers pollution prevention (see Table 1).

TABLE 1 Identification of Candidate Firms

	Organizations	Companies
Number identified	51	39
Number contacted	51	31
Number sent fax surveys	38	31
Number responding	19	18
Response rate for fax survey	50%	58%

A total of 51 organizations and experts were contacted to identify innovative companies for potential case study. A fax survey was sent explaining our motivation and asking that they suggest appropriate corporate candidates for investigation.

These interviews generated a list of 39 candidate firms including 3M, General Electric, Motorola, TRW, Steelcase, Sony, Honda, and others. We were able to obtain contacts at 31 of these companies. As a cross-check, we examined the toxic chemical reduction records available from the U.S. Environmental Protection Agency (EPA) for a group of roughly 50 manufacturing companies that are recognized as manufacturing innovators. While coverage of these companies in the EPA data was spotty, toxic chemical reduction data was available for a number of firms, and we were able to identify some additional companies for consideration in the case

studies. As Table 2 shows, a number of high-performance manufacturing companies registered considerable toxic chemical reductions, including: AMP, IBM, Johnson Controls, Kodak, Motorola, Sony, Timken, and Xerox among others.

TABLE 2 Environmental Performance of Selected High-Performance Firms

[33/50 Program Reductions]

Company Name	Industry	Location	Estabs.	Reduction	Percent
3M	Connectors/ resins	New Ulm MN	48	31,213,870	60.20%
AEG Westinghouse	Electrical equipment	Pittsburgh PA	43	1,284,600	45.40%
AMP	Electronic connectors	Harrisburg PA	2	383,065	80.60%
American Flange	Flanges, plugs	Carol Stream IL	1	129,750	81.30%
Caterpillar	Farm equipment	Peoria IL	17	932,557	60.60%
Corning	Ceramic filters	Corning NY	21	810,258	32.10%
Dana	Hydraulic control valves	Minneapolis MN	33	1,729,316	44.30%
Dupont	Mylar	Circleville OH	61	12,873,179	50.20%
Ford	Auto assembly	Wixom MI	53	3,852,624	21.70%
Honeywell	Fire alarms	Arlington IL	24	353,217	40.70%
IBM	Computer assembly	Rochester MN	13	3,478,293	71.00%
Johnson Controls	Electronics	Milwaukee WI	25	1,445,501	81.20%
Kodak	Imaging systems	Rochester NY	13	8,038,021	53.70%
Lord	Helicopter parts	Dayton OH	6	285,832	22.40%
Monsanto	Santoflex	Sauger IL	24	2,607,511	48.70%
Motorola	Integrated circuits	Schaumburg IL	18	660,812	58.90%
PPG	Glass	Pittsburgh PA	35	11,763,708	78.10%
SPX	Hydraulic tools	Owatonna MN	13	63,559	10.80%
Sony	Television	New Stanton PA	8	151,221	10.90%
Steelcase	Office furniture	Grand Rapids MI	14	526,545	19.40%
Timken	Roller bearings	Canton OH	15	969,316	73.30%
Xerox	Stamping	Webster NY	5	3,381,331	78.50%

These companies were contacted and asked to provide information on the involvement of suppliers in pollution prevention efforts. Companies were contacted by facsimile and 18 provided information on their environmental manufacturing efforts and indicated that they were willing to participate in the case studies and interviews (see Table 3).

Corporate Environmental Best-Practices Survey:

We conducted a survey of corporate environmental best-practices. The survey was administered to 450 manufacturing firms, drawn from the Standard and Poor (S&P) directory of manufacturing firms and included 250 larger firms from the S&P 500 Index, 100 mid-size firms from the S&P Midcap 400 Index, and 100 small firms from the S&P Smallcap 600 Index. The survey obtained information on supply chain management, zero emission manufacturing, total quality environmental management, pollution prevention activities, and the role of industrial

performance in stimulating environmental innovation. The survey was administered via facsimile, and led to successful contacts of 423 of the 450 firms. Of this number, 256 firms completed and returned the survey, a response rate of 60.5 percent.

This study also makes use of a survey of some 1,500 Japanese manufacturing *transplants*. The survey has extensive information on the use of high-performance manufacturing practices by these companies, and is used to explore the relationship between green design and high-performance manufacturing.¹

¹ The transplant survey examined the adoption of innovative manufacturing and work organization practices by 1,200 Japanese transplants and more than 300 U.S. suppliers to the automotive transplants. The survey collected detailed information on plant-level characteristics and products, work organization, manufacturing process innovation, and end-user/supplier relations. It was administered through a combination of mail and telephone contacts and resulted in an unadjusted response rate of 40 percent. While the main purpose of the survey was to examine the factors affecting the adoption of innovative manufacturing and work organization in the manufacturing plants, the survey included a question on the integration of environmental considerations in the design of products, which mail survey respondents (n=316) answered. These survey data were used to examine the relationship between green design and other aspects of advanced manufacturing.

TABLE 3 Companies Participating in Supplier Management Fax Survey

Company	Response
3M	No response
Amko Plastics	Response
Baxter Healthcare Corporation	Response
Boeing Defense and Space Group	Response
Cintech Industrial Coatings	Response
Crenlo, Inc.	Response
Crown Cork and Seal, Inc.	Response
Diebold	Response
GE Super Abrasives	No response
Honda of America Manufacturing	No response
Hunting Industrial Coatings	Response
IBM Corporation	Response
International Paper Company	Response
McLean Midwest	No response
Mead Corporation	No response
Motorola Inc.	Response
Nippondenso Manufacturing	Sent letter
Nordic-Ware	No response
Perry and Derrick	No response
Proctor and Gamble Paper Products	No response
Quad Graphics	Response
Ray-O-Vac	Response
Safety-Kleen	Response
Scott Paper Company	Response
Sematech	Response
Sony Electronics Inc.	No response
Steelcase Inc.	No response
The Boeing Company	No response
TRW Inc.	Response
Total Responses	18
Total Surveys Circulated	31
Response Rate	58%

Case Studies of Best-Practice Supplier

Management: The key aspect of this project involved detailed case studies of high-performance supplier management strategies and pollution prevention by leading companies in the Great Lakes region, and particularly in the Great Lakes Basin. As noted above, we contacted a wide range of organizations and experts to identify candidate firms for case studies, including trade associations, environmental agencies, and pollution prevention agencies. We also involved project advisory board members in developing the list of potential case study companies. Ultimately, 33 firms were contacted and participated in interviews.

Case studies, consisting of both in-person visits and extensive telephone interviews, were conducted with nine companies in various industrial sectors. These companies are manufacturing leaders in the Great Lakes region and have numerous plants in the Great Lakes basin:

- IBM, computer disk drives
- Sony, televisions
- Ray-O-Vac, batteries
- Safety Kleen, chemicals
- Amko Plastics
- Tuscarora Plastics
- Crown, Cork and Seal, aerosol cans
- Scott Paper
- Quad/Graphics, printing

The case studies obtained information on corporate and plant-level environmental manufacturing initiatives, the relationship between environmental strategies and manufacturing innovation, and the role of supply chain management in pollution prevention and environmental improvement.

Dissemination Activities: The project's key findings and policy implications were actively disseminated to regional, basin-wide, and national business, policy, environmental and academic audiences during the period January through July 1996. Project consultant, Sheila Leahy, played a strategic role on these dissemination activities. This was an important process for engaging the interest and support of a broad cross-section of key decision-makers as well as for soliciting their ideas and perspectives. Key dissemination activities included the following:

Major Policy Presentations:

- Great Lakes Pollution Prevention Roundtable
- National Pollution Prevention Roundtable
- Annual Meeting of the Great Lakes' Governors
- Second World Congress on Zero Emissions

Academic Presentations:

- Kennedy School of Government, Harvard University
- Harvard Business School
- Harvard-MIT Industrial Ecology Seminar
- Annual Meeting of the Association of American Geographers

Distribution to Major Policy Groups: Key policy groups were provided with a copy of the draft report and their comments were actively solicited. The following is an illustrative list.

- Illinois EPA
- Environment Canada
- Hazardous Waste Research and Information center
- American Automobile Manufacturers Assn.
- Illinois Department of Energy and Natural Resources
- Solid and Hazardous Waste Education Center
- Wisconsin Department of Natural Resource
- Great Lakes Pollution Prevention Center
- Council of Great Lakes Governors
- Illinois State University/Department of Health Sciences
- MERRA
- Office of the Great Lakes/ MI DNR
- CAMP
- Pennsylvania Office of Pollution Prevention

Briefings of Washington based policy groups:

- White House, Office of Science and Technology Policy (OSTP), environment division
- Northeast Midwest Institute

Mailing: To national trade associations and groups. A sample of the types of groups that received the mailing include:

- National League of Cities
- Council of Economic Advisors
- National Association of Counties
- Competitive Enterprise Institute
- League of Women Voters
- Business for Social Responsibility - Education Fund

Opinion Editorial and Press Release: Opinion editorials and press releases have been prepared for release and dissemination in fall 1996.

Press Coverage: The study received front page coverage in *Manufacturing News*, July 1, 1996, based upon presentation to the *Second World Congress on Zero Emissions*.

Publications: The study findings are summarized in an article entitled, "Lean and Green: The Move to Environmentally Conscious Manufacturing," published in *California Management Review*, Fall 1996. Other papers and publications are being written.

Related Funding: Based in part on project research, the PI received funding of \$110,000 from the National Science Foundation, Environmentally-Conscious Manufacturing Program to conduct basic research on the adoption of environmentally conscious manufacturing practices by U.S. manufacturing plants. Research is currently underway.

THE ENVIRONMENT AND THE HIGH PERFORMANCE REVOLUTION

Competitiveness is an increasingly important driver of corporate environmental strategies. As Figure 1 shows, companies rated a series of factors related directly to industrial performance and competitiveness - capitalizing on new technology, serving key customers, and improving productivity - as key factors in their environmental strategy. While companies continue to see environmental regulations and corporate citizenship as important, competitiveness considerations are increasingly important to corporate environmental strategy.

Total Quality Environmental Management

Total quality management is a key feature of high-performance manufacturing. Total quality management is essentially a method for involving production workers in the improvement of product quality through incremental improvements in both products and processes. According to the President's Commission on Environmental Quality, total quality environmental management (TQEM) extends the principles of quality management to include manu-

The case studies indicate that a number of manufacturing firms are migrating from the traditional ISO 9000 standards to the new ISO 14000 standards.

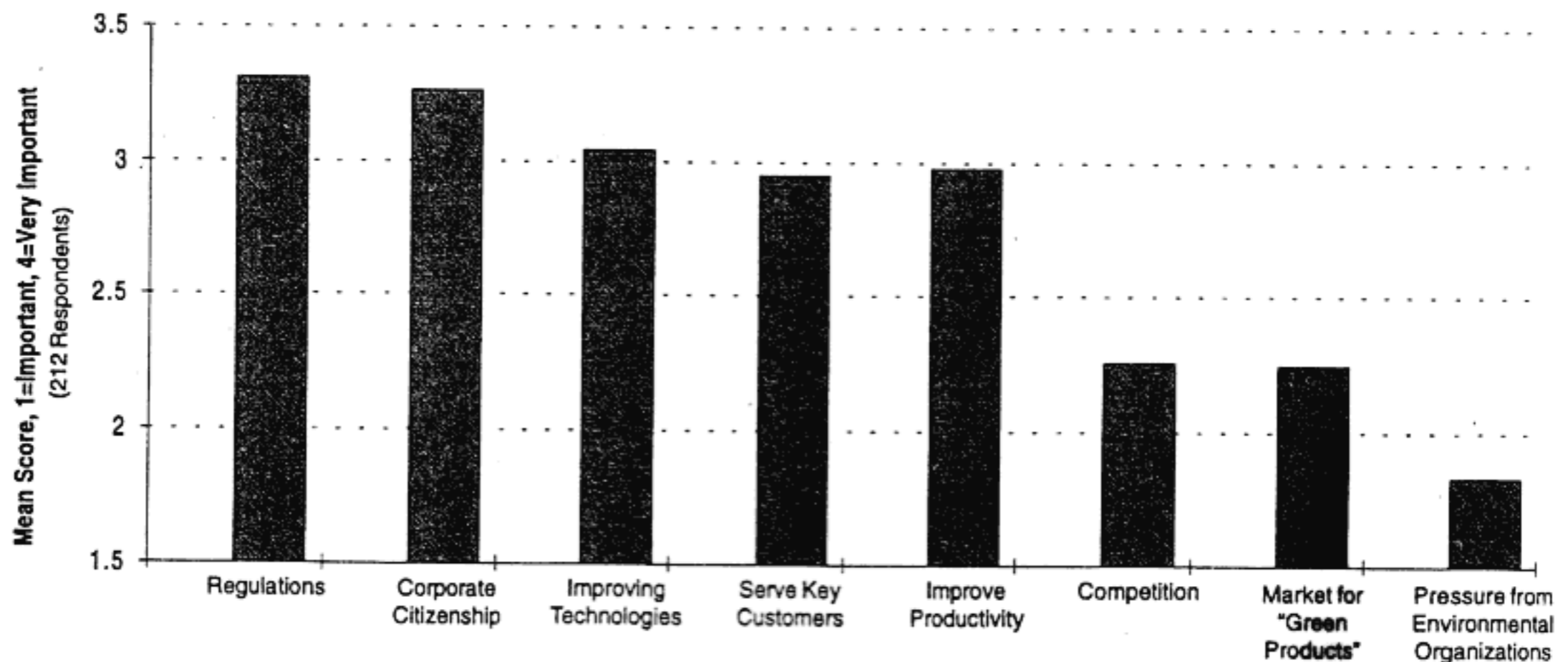
- Ray-O-Vac was already operating at 95 percent of ISO 14000 standards.
- Safety Kleen's, Elk Grove, Illinois plant was in the process of moving from ISO 9000 to ISO 14000 standards.
- Sony Corporation was shifting from ISO 9000 to ISO 14000 standards for its North American and worldwide manufacturing operations.

Zero Emission Manufacturing

Zero emission manufacturing involves the complete elimination of all environmentally damaging byproducts from the production process. A significant number of companies - more than 15 percent - are actively pursuing zero emission manufacturing. And, nearly 85 percent of companies are pursuing reduced emissions strategies.

Most companies said that zero emission manufacturing is in its early stages of development, and that at this point it functions as a goal or target rather than as an adopted practice or standard. They emphasized

FIGURE 1 Key Factors in Corporate Environmental Strategy



Source: Richard Florida, *Survey of Environmental Manufacturing Processes*, 1995.

that such targets are useful to motivate ongoing improvement efforts even though it may currently be impossible to achieve zero emissions in practice. A number of companies drew a parallel between zero emissions manufacturing and the quality or zero defect movement of the 1970s and 1980s, citing zero emission strategies as an emerging source of competitiveness for the 1990s and beyond.

Worker Involvement and Continuous Improvement

Employee involvement in continuous manufacturing improvement is a key element of high-performance manufacturing. Two-thirds of companies in the survey involve production workers in their pollution prevention efforts. Companies rated only two other groups - top management and engineers - ahead of factory workers in pollution prevention efforts. These groups are increasingly working together in teams to generate productivity-enhancing environmental outcomes.

The role of employees in pollution prevention was highlighted by a number of firms.

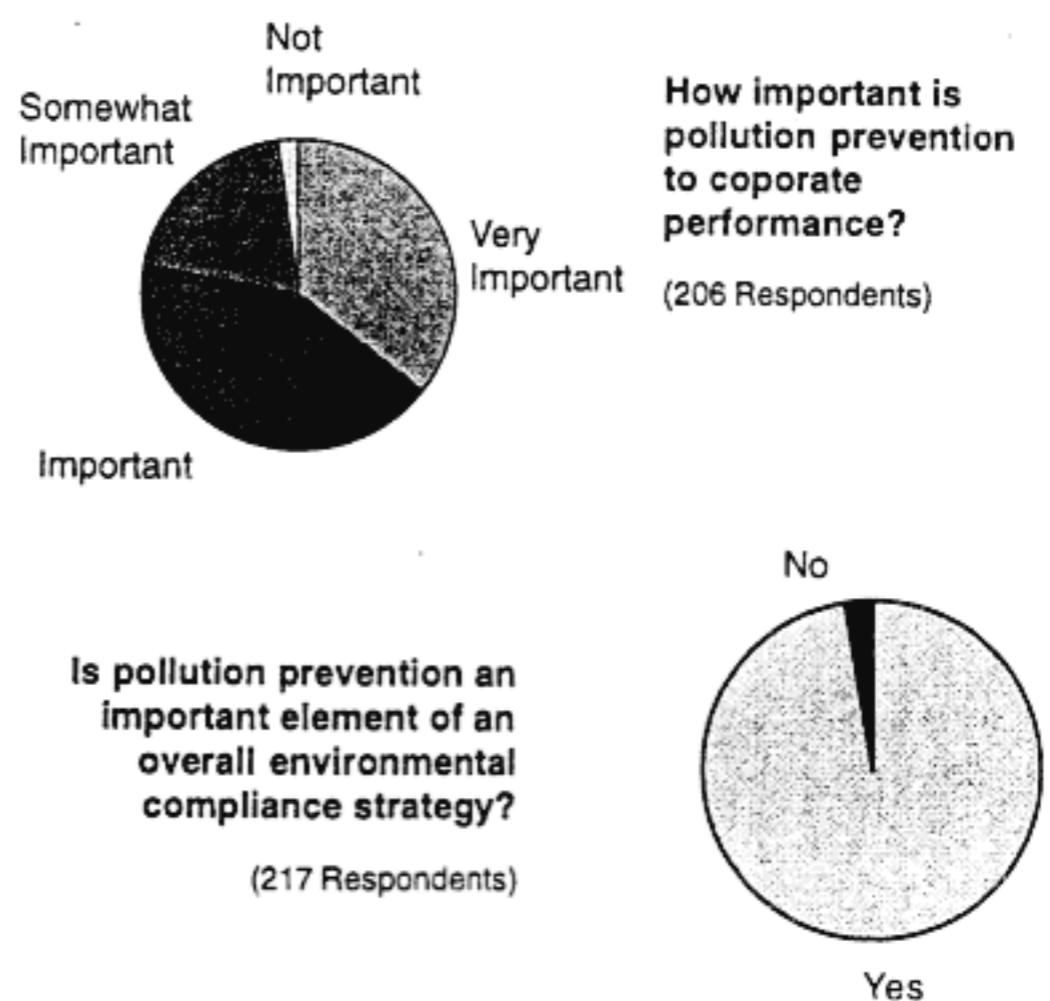
- Quad/Graphics used employee teams to significantly reduce hazardous waste. The company reported that employee involvement was a cost-effective way to improve environmental outcomes and reduce costs, involving incremental changes in existing processes and products as opposed to major changes in technology and large capital expenditures. The firm reported that as a result of these measures it reduced hazardous waste by 27 percent and non-hazardous liquid waste by 47 percent over two years in its Wisconsin plants, with estimated cost savings in excess of \$600,000.
- IBM's disk drive plant involved workers, engineers, and R&D scientists in a plant wide effort to reduce CFCs.
- Safety-Kleen used teams of workers and engineers to reduce solvents, minimize waste, and redesign equipment for increased resource efficiency and pollution prevention.
- Crown Cork and Seal's Fairbault, Minnesota

plant involved production workers as the centerpiece of its efforts to eliminate waste and reduce toxins, forming teams of production workers to focus on environmental issues - for example, a *Recycling Team* whose objective focused on an environmental problem, and the *Color Cats Team* whose main effort was quality improvement but whose work had considerable impact on hazardous waste generation. As a result of these efforts, the plant achieved a 60 percent reduction in use of its primary solvents between 1991 and 1993, a 36 percent reduction of air emissions in 1993, and a three-fold reduction in solid waste disposal from an annual level of 300 tons to 100 tons that same year. Crown Cork & Seal is a Fortune 500 company with annual sales of \$4.2 billion. The Fairbault, Minnesota plant produces roughly 15 percent of all aerosol cans in North America.

Pollution Prevention through Process Modernization

Pollution prevention is a central element of the shift from traditional end-of-the-pipe environmental strategies to high-performance production systems. More than three-quarters of companies report that pollution prevention is important to overall corporate

FIGURE 2 Pollution Prevention, Environmental Strategy and Corporate Performance



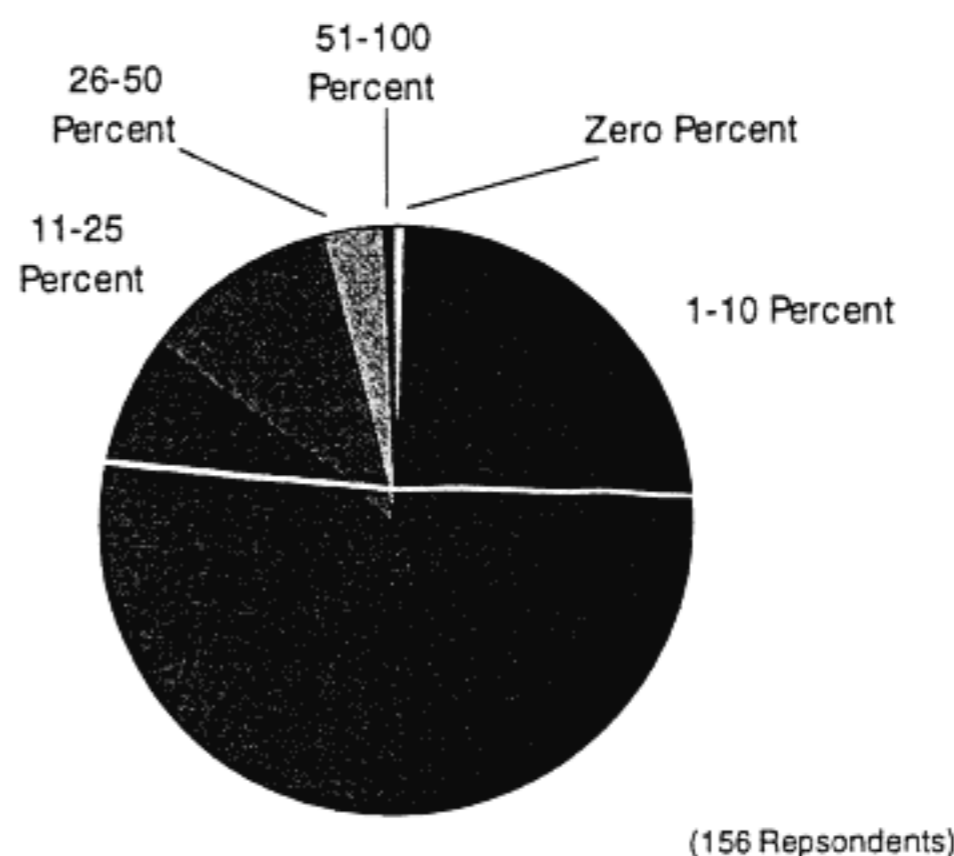
Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

performance (see Figure 2). Nearly 90 percent of companies said that pollution prevention is an important element of their overall environmental compliance strategy. Just one-fifth of companies said that pollution prevention is only somewhat important to corporate performance, and just 2 percent indicated that pollution prevention is not important to their corporate performance.

Pollution prevention expenditures make up a sizeable share of overall capital expenditures for the companies in the survey. Nearly 85 percent of companies devote between 1 and 10 percent of their total capital expenditures to pollution prevention (see Figure 3). And, more than one in six firms devote greater than 10 percent of their total capital spending to pollution prevention. Just half of one percent of firms do not devote any capital expenditures to pollution prevention.

Companies in the survey clearly favor more innovative approaches to manufacturing process improvement as well as source reduction and recycling over traditional treatment and end-of-the-pipe control remedies (see Figure 4). More than three-quarters of companies report that production process improvements, source reduction, and recycling are main elements of their pollution prevention strategies. Significantly smaller percentages use control or end-of-the-pipe technology as main elements of their

FIGURE 3 Share of Capital Expenditure Devoted to Pollution Prevention (Percentage of Total Respondents)

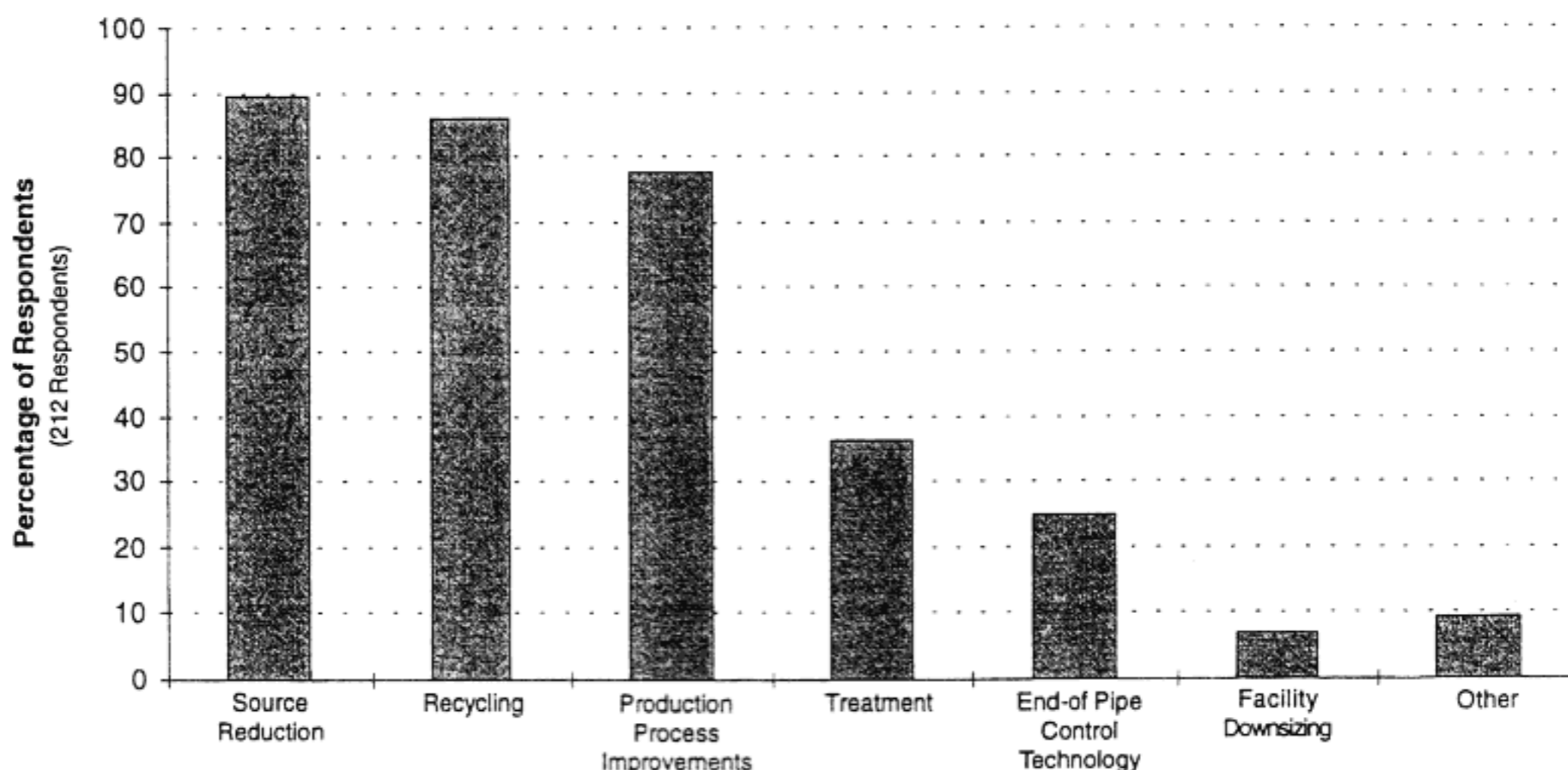


Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

pollution prevention strategy. And, very few firms see downsizing as a route to environmental improvement. Just 7 percent of firms said that downsizing was a main element of their pollution prevention efforts.

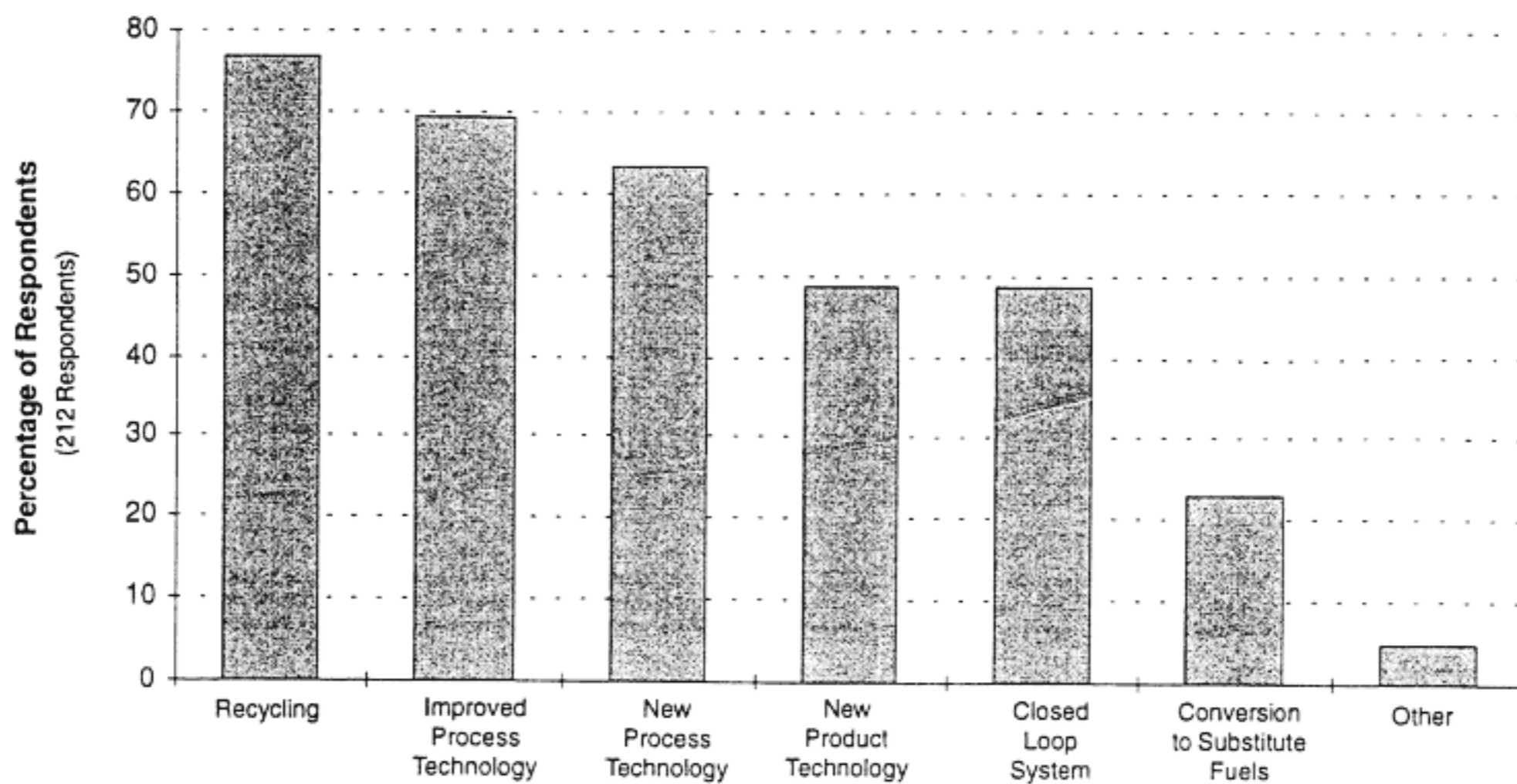
Production process modernization is a major way to leverage high-performance manufacturing to prevent pollution and achieve better environmental perfor-

FIGURE 4 Elements of Pollution Prevention Efforts



Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

FIGURE 5 Types of Production Process Improvements Made to Prevent Pollution



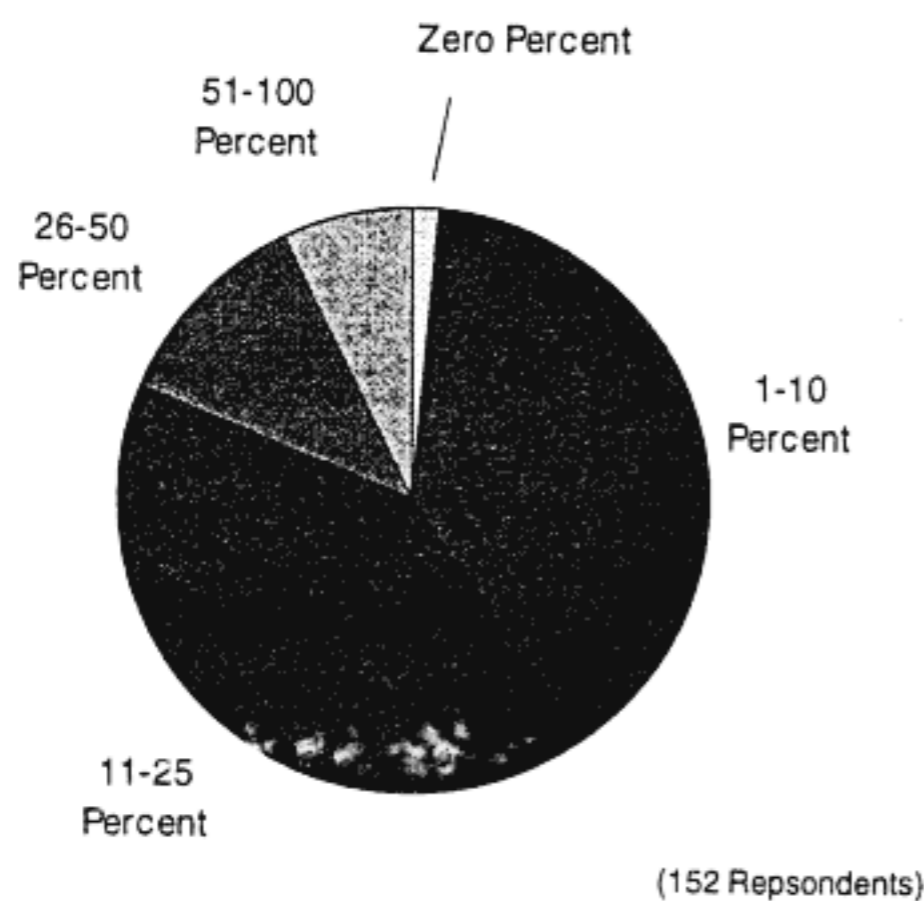
Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

mance. Companies clearly favor recycling and improvements in manufacturing process technology over control technology and waste treatment (see Figure 5). Roughly two-thirds of companies upgraded their existing process technologies and introduced wholly new process technologies in their efforts to prevent pollution and improve their environmental performance. In addition, more than three-quarters of companies were involved in

recycling. And, nearly half of companies introduced new product technology or closed loop production systems. Instead of cutting production or simply treating wastes, firms are investing in continuous improvement of their manufacturing processes to simultaneously prevent pollution and increase productivity.

These efforts have paid off in considerable emission reduction. Roughly 60 percent of companies said that they reduced emissions by greater than 10 percent over the previous year, with 40 percent achieving reductions in the range of 11 to 25 percent, 12 percent in the 26-50 percent range, and 7 percent reporting reductions in excess of 51 percent. Only 1 percent of companies said that they achieved no emission reductions at all (see Figure 6).

FIGURE 6 Level of Emission Reduction



Green Design

Green design is an increasingly important component of high-performance manufacturing. We used data collected from a survey of Japanese manufacturing transplants and their U.S. suppliers to examine the relationship between innovations in environmental manufacturing and the use of high-performance manufacturing. This analysis led to two main conclusions.

Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

TABLE 4 Green Design by Type of Manufacturing System

Manufacturing Practice	Type of Manufacturing System		
	Taylorist	Transitional	High-Performance
*Green Product Design	No	--	Yes
Total Quality Management	No	Yes	Yes
Quality - Oriented Design	Limited	--	Extensive
Quality - Oriented Process Improvements	Infrequent/Limited	Frequent/Extensive	Frequent/Very Extensive
Inventory	High*	Moderate*	Low*
Concurrent Engineering	Limited	--	Extensive
Ratio of Managers to Workers	High	--	Low
Employment Security	No	--	Yes (No Layoff Pledge)
Supplier Relations	Arm's Length	--	Cooperative
Electronic Design Interchange	No*	--	Yes*

Note: * Indicates that finding is mainly attributable to the automotive sector.
 -- Indicates that there is no statistically significant relation between the given characteristic and the type of manufacturing regime at the p < .01 level.
 Source: Davis Jenkins, *Japanese Transplants and the Work System Revolution in U.S. Manufacturing*, 1995.

First, green design is one of a cluster of practices that define high-performance manufacturing. We used a statistical technique referred to as cluster analysis to identify manufacturing establishments according to whether they used Taylorist, transitional, or high-performance approaches to manufacturing (see Table 4). Green design was one of the practices most closely associated with high-performance manufacturing.

Second, green design is closely associated with highly innovative companies (Table 5). Plants that use green design are larger, more R&D intensive,

TABLE 5 High-Performance Manufacturing and Green Design

Factors Associated with Adoption of Green	Green Design Plants	Non-Green Design Plants	Significance Level
Employment	472	243	**
Sales	\$145.3 million	\$62.2 million	**
R&D Spending	\$4.2 million	\$0.4 million	**
Capital Investment	\$56.0 million	\$46.8 million	*
New Product Introductions	9.4	4	**
Product Design Changes	14.9	8.4	**
Suggestions by Production Workers	185	87	**
Total Quality Management (percent of plants)	71%	56%	*
Statistical Process Control (percent of work force)	40%	27%	**
Inventory (current level)	9 days	12.7 days	*
Return on Assets	13.6%	8.5%	**

Note: * is significant at the .05 level. ** is significant at the .01 level.
 Source: Data from Richard Florida and Davis Jenkins, *Survey of Japanese Affiliated Manufacturers and Their U.S. Suppliers*, 1995. Mark Atlas conducted the statistical analysis.

make greater numbers of products and product designs, and involve workers in continuous improvement. The green design plants spent on average ten times as much on R&D as those which did not. They were twice as large, on average, in terms of employees and sales. The green design plants also introduced roughly twice the number of new products and new product designs. And, they were more likely to be involved in total quality management, utilize statistical process control, and have lower levels of inventory.

SUPPLY CHAIN MANAGEMENT AND POLLUTION PREVENTION

What is the role of suppliers and supply chain management in the integration of environmental and high-performance production strategies? To what extent are high-performance manufacturers using their supplier chains as vehicles for spreading innovative approaches to pollution prevention and environmental improvement?

Supplier relations and supply chain management affect the industry-environment nexus in numerous ways. On the one hand, manufacturers have at times used their suppliers as a vehicle for improving their own environmental records by out-sourcing toxic elements of the production processes, essentially pushing waste and toxins down the supply chain. On the other hand, new models of supplier relationships and supply chain management create opportunities for joint approaches to improve productivity and prevent pollution.

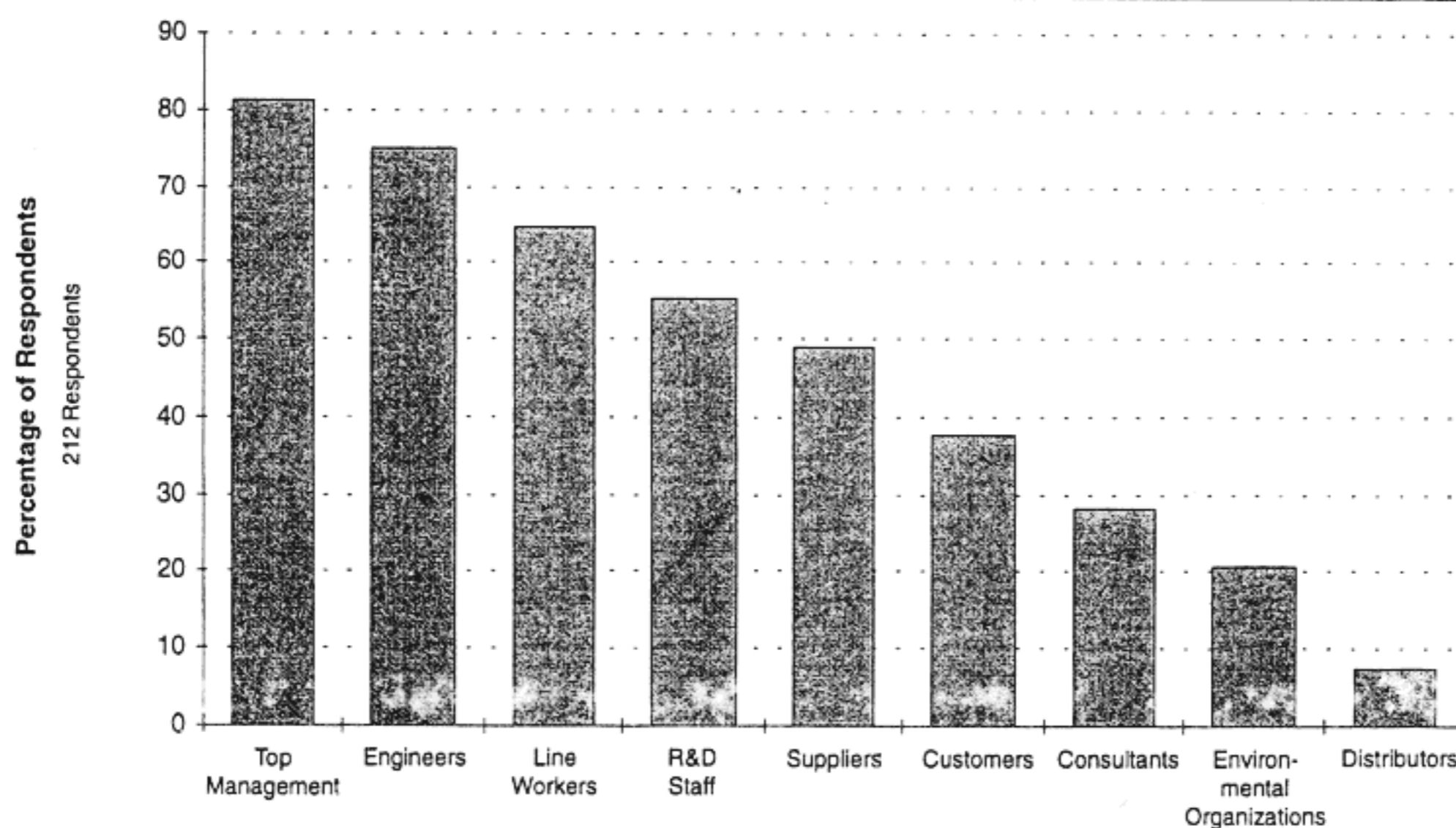
Companies are clearly involving their key suppliers in efforts to improve environmental outcomes and

increase productivity. As Figure 6 shows, roughly half of companies in the corporate environmental best-practice survey identified suppliers as a key player in pollution prevention efforts. Suppliers were the top ranked player in pollution prevention efforts outside the corporation, and ranked fifth overall. Only key groups inside the corporations ranked higher: top management, engineers, R&D staff, and production workers. In addition, nearly 40 percent of companies said that customers are key players in pollution prevention efforts. As these responses make clear, there can be little doubt that the entire production chain from supply to final delivery is an increasingly important player in pollution prevention.

To shed additional light on this issue, we conducted a more focused survey of the particular supply chain management strategies used by leading manufacturing companies in the Great Lakes region and Great Lakes basin (see Table 6). These companies are involving their suppliers in pollution prevention in a series of interesting ways.

- Nine in ten companies hold meetings with their suppliers to relate their pollution prevention strategies.

FIGURE 6 Key Actors in Pollution Prevention Efforts



Source: Richard Florida, *Survey of Environmental Manufacturing Practices*, 1995.

TABLE 7 Results of Corporate-Supplier Survey

In what ways does your company interact with their suppliers in order to reduce pollution and toxic discharge?	Number of Positive Responses	% of Total Responses
Hold supplier meetings to relate pollution prevention strategies.	17	94%
Develop purchaser specifications embedded environmental objectives.	15	83%
Work with suppliers to develop new products or specifications.	15	83%
Shop for materials and products meeting the specific need of a specific pollution prevention project.	13	72%
Conduct efforts such as TQM (bringing suppliers into action teams), life cycle design, etc.	11	61%
Attend "Green" product sales booths at conferences.	10	56%
Other: please write description below.	10	56%
Provide incentives to suppliers to measure supplier performance in a way that creates incentives for pollution prevention.	5	28%
You advertise for certain types of products to purchase.	2	11%
Not at all.	0	0%

- Eighty percent develop specifications which include environmental objectives are embedded and work with suppliers to develop new products and specifications.
- Nearly three-quarters of companies actively search out materials and products to meet the specific needs of pollution prevention projects.
- Nearly two-thirds of companies conduct efforts such as TQM or life cycle design.

The case studies and interviews provided numerous examples of the role of suppliers in pollution prevention activities. Supplier-based prevention strategies included: building environmental objectives into supplier specifications, providing technical support, and working with suppliers to develop environmentally-sensitive products.

- Motorola proactively pursues pollution programs with its suppliers.
- IBM's disk drive factory worked closely with circuit-card suppliers to jointly develop a water-based alternative to a CFC-based chemical.
- Scott Paper and Safety-Kleen worked closely with suppliers to eliminate toxic chemicals and reduce waste through recycling and process changes.
- Amko Plastics formed *action teams* with suppliers to develop new materials and processes. It worked with its resin suppliers to develop new materials which offer superior strength and improved environmental impacts, resulting in a 25-40 percent reduction in raw materials and solid waste. It worked with other key suppliers to develop systems, materials and processes to convert entirely to water-based inks for printing plastic films.
- Ray-O-Vac established an environmental audit and ranking system for its suppliers and worked closely with its first tier of suppliers to encourage the use of pollution prevention practices through the supply chain. They do not qualify vendors who score low on their Environmental Criteria Ranking System. Furthermore, poor environmental performance can disqualify a supplier, while strong environmental performance can qualify a vendor for bonus contracts.
- TRW was in the process of adding an environmental component to its existing supplier assessment program.

But, more important than these specific and directed efforts, the case study companies emphasized that supplier relations create considerable opportunities for joint environmental and productivity improvement. In particular, they stressed that environmental improvements most frequently come from ongoing efforts to improve productivity and implement high-performance manufacturing, more so than from more directed efforts to transfer pollution prevention strategies and technologies. For example, the emphasis on just-in-time delivery seeks to reduce

both inventory and waste. Pressure for continuous cost reduction and quality improvement create additional incentives for waste reduction and cost savings. Increasing co-involvement in product development between end-users and suppliers provides opportunities for the design of new products and processes that are both more efficient and environmentally benign.

Sony's Westmoreland, Pennsylvania advanced television plant and its suppliers provides a compelling example of how environmental improvements can flow naturally from ongoing joint efforts to improve productivity, eliminate defects, and reduce costs, rather than from direct efforts to transfer pollution prevention technology or organizational strategies designed expressly to eliminate toxins or prevent pollution.

- As part of its effort to reduce cost and waste, the Sony plant worked with its suppliers of plastics, metals, solder, and other materials to completely recycle all of the scraps and other products of the production process.
- Sony worked closely with one of its suppliers, Tuscarora Plastics, to redesign its packaging to be less costly - a design which also used less material and generated less waste.
- The Sony plant also collaborated with a major paint supplier to reduce the cost of paint by switching to a water-based substitute which was also more environmentally sensitive than chemical-based paints.

In short, supplier relationships and supply chain management open up new and important pathways for pollution prevention and environmentally-conscious manufacturing. And, they do so as part of the more general shift to high-performance manufacturing. The following pages provide more detailed summaries of the best-practice approaches to supply chain management used by the case study companies.

Best-Practive Approaches to Supply Chain Management

IBM: Working with Suppliers

IBM's disk drive factory in Rochester, Minnesota involved its suppliers heavily in efforts to eliminate CFCs from the production process. This effort began with engineers inside the plant. After the first few months, however, it had strong corporate-wide commitment and involved management, R&D, engineers, and line workers. This CFC elimination program was broad-based in focus, looking for all opportunities to reduce CFC use at the source.

Supply chain management quickly became a key component of this process. When the product development and purchasing departments became involved with the CFC elimination program, they went to suppliers to seek out options. Although IBM was already redrafting its specifications concerning CFCs and holding seminars for suppliers, it was eager to work with them more closely to develop strategies. At times, suppliers could not meet new specifications. In such cases, IBM worked with the suppliers on an engineering level, jointly trying to locate the source of the problem by examining production processes in detail. While IBM provided technical assistance, troubleshooting and some R&D support, the suppliers did 80-90 percent of the work involved.

A strong example of leveraging of the supplier network occurred in the development of a water-based alternative to a CFC-based chemical used by its circuit card suppliers. After developing this alternative process for use by its suppliers, IBM found that some had problems dealing with their municipal water supplies, leading to further chemical problems. The question for suppliers then became "What can we do to clean up our water supply in general?" This is an excellent example of a hub manufacturer diffusing its approach to process improvement for pollution prevention. IBM led its suppliers to reexamine their own processes in ways that would improve their environmental performance.

Although IBM has scaled back production in Rochester, the legacy of this project continues through the improved environmental performance of its key suppliers in the Great Lakes region and basin.

Ray-O-Vac: High-Performance Pollution Prevention

Ray-O-Vac's Madison, Wisconsin plant places a high priority on pollution prevention. The company has a long commitment to high-performance manufacturing. Ray-O-Vac has been a just-in-time producer for more than a decade. The company emphasizes product quality and close-knit supplier relations, encouraging long-term relationships with suppliers. The Madison plant is ISO 9000 certified, and operates at 95 percent of ISO 14000 standards. It is working to integrate its total quality, employee involvement, and pollution prevention programs.

Ray-O-Vac works with its first tier of suppliers to encourage the diffusion of pollution prevention. The purchasing department conducts educational programs with suppliers. The company has worked closely with its chemical suppliers to achieve pollution prevention, and has encouraged a number of them to enter Chem-Care programs.

Ray-O-Vac makes extensive use of environmental auditing of suppliers, using on-site interviews and reviewing training records. They work with suppliers to identify ways that through their relationship they can make it easier for suppliers to eliminate waste, reexamining specifications and processes with an emphasis on waste reduction. Poor environmental performance can disqualify a supplier, while strong environmental performance can qualify a vendor for bonus contracts. The company is seeing results in improved pollution prevention through the top three tiers of its supply chain.

Safety-Kleen: Working Backward and Forward across the Supply Chain

Safety-Kleen is a provider of waste disposal and parts cleaning services, with a major manufacturing facility in Elk Grove, Illinois. Safety-Kleen shows a commitment to high-performance manufacturing and dedication to ISO 9000 and ISO 14000 principles. Its

innovative environmental programs involve all employees in pollution prevention, including line workers and engineers.

Safety-Kleen has a strong internal pollution prevention program, linked explicitly to continuous process improvement and other high-performance practices. It is an active participant in the Chemical Manufacturers Association's Responsible Care Program, and is committed to leadership in pollution prevention and waste minimization. Safety-Kleen's most focused program is its Waste Minimization 2000, aimed at reducing the solvent used by its degreasers, reducing waste, and redesigning its equipment for increased resource efficiency.

Safety-Kleen interacts with both suppliers and customers to advance pollution prevention. On the supply end, the company has focused its buying strategies on cleaner supplies, containing fewer contaminants. For the past two years, it has been factoring in environmental impact as part of the supplier selection process. Safety-Kleen works with key suppliers on a long-term basis, choosing suppliers which are consistent with its focus on product quality and resource conservation. It has entered into recycling agreements with certain suppliers. The company also works with customers on environmental issues, recycling as much of its products as possible and working to reclaim wastes as potential fuels.

Quad/Graphics: Cost Savings via Environmental Strategy

Quad/Graphics, based in Pewaukee, Wisconsin is a leader in cost-saving methods for improving environmental performance, and is an industry leader in a wide variety of collaborative environmental programs. It is an active member of Businesses for Social Responsibility and a leader in the Great Printers Project. Both projects aim at developing collaborative strategies for pollution prevention within the printing industry

Waste reduction programs inside the company revolve around employee involvement. Employee-led efforts reduced hazardous waste 27 percent in two years in the company's Wisconsin plants, and cut non-hazardous liquid waste by nearly half. The cost

savings from these programs during those two years was estimated to be over \$600,000. By far, the lion's share of improvements came from common sense, and did not involve major new capital expenditures.

Quad/Graphics' environmental program emphasizes recycling and purchasing requirements. Already a leader in the development of printing techniques using recycled materials, Quad/Graphics is looking at the supply chain as a tool for furthering the use of recycled products. It is committed to increasing the amount of recycled products it buys, and is working with suppliers on innovative projects. For example, the printing firm has worked with its suppliers of plastic strapping to create a recycling loop which saved 117 tons of plastic strapping in 1992 alone.

Amko Plastics: Suppliers and Sustainable Manufacturing

Amko Plastics makes suppliers a key component of its commitment to sustainable manufacturing and clean production. It is dedicated to developing new processes and materials which not only improve the performance and value of its products for customers, but also reduce the environmental impact of its manufacturing activities and products.

Amko has involved key suppliers in a host of programs to reduce pollution and toxic discharge, conserve energy, and eliminate waste. The company, which is a plastics processor engaged in film extrusion, injection molding, flexographic printing, photopolymer plate processing, and ink mixing and blending, has eliminated toxic wastes throughout its operations. Amko is currently classified under the lowest category of hazardous waste generator, generating less than 220 pounds of hazardous waste per month, all of which comes from the kerosene used to clean metal parts in the machine shop. Amko reports that it could not have made these achievements if key suppliers were not an integral part of its efforts.

In addition to company sponsored programs, Amko has been invited by suppliers of plastic raw materials, color concentrates, printing inks, extrusion equipment, printing plate processing equipment, printing presses, and specialty film additives to work jointly

in the development of new technologies and products which enhance product quality and generate environmental benefits at the same time.

Amko reports the following environmental achievements as a result of partnerships with key suppliers.

- In 1979, the company became the first U.S. film and bag producer to introduce thin-gauge, low-density polyethylene materials (linear low density polyethylene) which made the first substantive source reduction benefit in shrinking solid waste generated by the plastic bag industry.
- In 1984, Amko became the first plastic film printer to eliminate alcohol based inks to reduce air pollutants in the printing process, working with suppliers to develop the systems, materials and process to convert entirely to water based inks for printing plastic film. This resulted in an 85 percent reduction in the emission rate of alcohol to the atmosphere.
- In 1987, the company replaced ink pigments based on potentially toxic heavy metal bases with non-heavy metal counterparts.
- In 1992, Amko eliminated the use of perchloroethylene as a solvent in the production of its printing plates and replaced it with a petroleum blend.
- Amko is working with suppliers to develop corrugated cartons which incorporate a liner board manufactured from recycled newspapers.

Sony: Leveraging High-Performance for Environmental Improvement

Sony Corporation is a leading high-performance manufacturer. Its plant in Westmoreland Pennsylvania, on the site of the abandoned Volkswagen automotive assembly facility, produces advanced large-screen rear-projection televisions for the North American market. Sony is committed to the goals of defect minimization, zero inventory, and pollution prevention. The company has a corporate wide policy to reduce emissions and waste, being

“committed to protecting and improving the environment in all areas of the company’s operations, ... and, to continually seek the improvement of environmental quality as it relates to our products, our packaging, and our operations.” Sony believes that environmental manufacturing is an emerging source of competitive advantage today, in the way that quality was in the 1970s.

Sony’s major environmental improvements flow out of efforts to improve productivity and quality, not a result of explicit environmental programs. A key source of Sony’s competitive edge is that it successfully links environmental performance to its bottom line. Sony links its environmental improvement efforts to product and process design, and also involves all employees in the initiative.

At the Westmoreland plant, this approach covers the entire supply chain. Suppliers must meet quality and environmental standards, and they continually interact with Sony staff to identify potential improvements. For example, Sony’s Westmoreland facility in Pennsylvania is working with Tuscarora, a supplier of plastics, to redesign packaging using less material. The plant also is collaborating with paint suppliers to create environmentally friendly substitutes for chemical-based paints.

HARNESSING THE HIGH PERFORMANCE REVOLUTION FOR THE ENVIRONMENT

The high-performance revolution is causing a massive shift in corporate environmental strategy and pollution prevention. Three elements of this transformation, in particular, are worth emphasizing.

- Corporate environmental efforts are increasingly bound up with broader efforts to improve competitiveness by adopting high-performance manufacturing systems and strategies. Manufacturing firms are leveraging their industrial modernization strategies to achieve environmental improvement. Pollution prevention and green design have become defining elements of best-practice high-performance manufacturing. Manufacturing firms prefer productivity-enhancing process improvements over traditional approaches to treatment and end-of-the-pipe controls. Environmental performance - and particularly pollution prevention - is an increasingly important component of overall corporate performance.
- Industrial competitiveness is an increasingly important engine of pollution prevention and improved environmental quality. While firms continue to be motivated both by regulations and corporate citizenship, environmental strategy is increasingly motivated by deeper drives to improve productivity, capitalise on new technology, and expand customer markets.
- Greater corporate reliance upon key suppliers opens up new pathways for regional environmental improvement. Manufacturing firms in the Great Lakes region and basin already involve their suppliers in a variety of pollution prevention activities and they are experimenting a whole range of ways to use supply chain management to prevent pollution and improve their overall economic and environmental performance simultaneously. The biggest payoffs come from ongoing joint efforts to improve productivity, eliminate defects, and reduce costs, rather

than from direct efforts to transfer pollution prevention technology or organizational strategies designed expressly to eliminate toxins or prevent pollution.

Strategic Directions: Accelerating the High-Performance Revolution

The Great Lakes region is recognized internationally for the restoration of those lakes and it is becoming known as the world's first manufacturing region to bounce back from predictions of deindustrialization and decline to be a world-class center for high-performance manufacturing.

The high-performance revolution is an environmental as well as an economic revolution. It provides clear evidence that the "bottom line" is a key driver of environmental improvements in manufacturing. In this light, efforts to broaden and accelerate the High Performance revolution would benefit both the economy and the environment of the Great Lakes.

Current efforts to move away from command-and-control regulation and end-of-the-pipe controls, and to emphasize market-based environmental regulations and regulatory flexibility are all good ideas, and are all worth doing. But, just doing that is not enough.

A more ambitious agenda is required if the Great Lakes region is to secure its place as the first major industrial region to rebuild both its economy and its environment along high-performance lines.

Regional policy-makers can accelerate this transformation by acting on the following six points.

Link the Region's Environment and Competitiveness Agendas

As a first principle, efforts must be undertaken to explicitly link the region's economic and environmental agenda. The high-performance revolution establishes the underlying dynamic which makes it possible to link environment and competitiveness. As such, environmental and economic policies must also be linked. Throughout the study, companies noted that the fragmentation of economic and environmental policies makes it difficult to link the environment

with regional competitiveness. Firms are tired of the traditional command and control regulatory structure and are demanding change. That structure is costly to maintain as well. Furthermore, improving productivity and becoming more competitive are increasingly the main motivations behind corporate environmental improvement. It is the high-performance industrial revolution, more so than government regulation, that is increasingly the engine behind industrial environmental improvement.

Government policy, at the regional, state and local level, as well as at the federal level, must overcome the fragmentation between environmental and economic development program areas and increasingly act to spur and motivate the deeper process of high-performance economic transformation. Environmental considerations should be integrated into all regional efforts to move to high-performance production and in related workforce development agendas.

One principle can serve as the cornerstone of these efforts: The objective and mission of government policy must be to **simultaneously improve economic and environmental performance.**

Let High-Performance Firms Lead

High-performance manufacturers are the engines of this industrial-environmental revolution, and their input and knowledge is badly needed. There is a great deal to be gained from involving them in reshaping and restructuring environmental and economic policies. To this end, the region should find mechanisms to involve the CEOs of leading high-performance corporations and other experts in providing strategic direction and advice on how to link the region's environmental and competitiveness strategies.

Decisive Political Leadership

Strong, consistent and unswerving political leadership is required to ensure the move to a high-performance economic and environmental agenda. The governors of the Great Lakes' states have long set the tenor for the nation with their leadership on environmental, competitiveness, and most recently with their pioneering welfare initiatives.

Market based environmental policy is not a new concept. In fact, over the past six years, both state and federal agencies have spent time and resources experimenting with pilot programs that prove the saliency of this concept. Furthermore, these experiments have proven the need for restructuring the current regulatory system of command and control, focusing on pollution prevention, and creating a multi-media approach to environmental management. Despite the wide spread acceptance of these ideas, the same outmoded federal regulatory system remains in place limiting growth and transformation.

What is needed is bold institutional reform of environmental policies and practices, along the lines of the welfare reform efforts. Experience has shown that tinkering around the edge with experimental programs is not enough. The system has to be overhauled and political leadership from the top is needed to do it.

Political leadership in the Great Lakes' region is well positioned to take up this challenge. The governors understand that government agencies must undergo top to bottom re-engineering for real change to take place, as evidenced by Governor Engler's and Thompson's clear and powerful national leadership on welfare and Governor Voinovich's efforts on job training.

High-Performance Requires a New Policy Framework:

The high-performance revolution demands a new policy framework — one that is attuned to the needs and demands of high-performance manufacturers. The existing environmental policy framework, which grew up during the age of mass production industry, functions as impediment to further economic and environmental revitalization. The following are principles which can guide state, regional, and basin-wide efforts to develop that new framework.

- **Make Policy Meet a High-Performance Test:** Environmental polices - and other policies as well - must meet the test of high-performance production. To that end, existing environmental policies should be reviewed in light of the demands of high-performance production. While

there is always an urge to create new policies and programs to address new problems, the real opportunity lies in streamlining and eliminating current policies which hold back the waves of change. We advocate a simple test. Those policies that support and leverage high-performance production should be maintained; those that do not should be restructured or eliminated.

- **Establish Cross-Agency Economic-Environmental Policy Teams:** It is commonly said that responsibility for economic and environmental policy is fragmented and that this makes it difficult to link the environment to regional competitiveness. Regional, state and local governments can overcome this problem by establishing cross-functional policy action teams composed of representatives of economic and environmental agencies to develop greater coherence in their agendas.
- **Establish Benchmarks for the High-Performance Industrial- Environmental Revolution:** It is essential to measure progress toward high-performance goals. Unfortunately it is impossible to use existing environmental and industrial statistics to chart progress in the high-performance revolution. Such benchmarks can only come from more focussed surveys and case studies, of the sort used in this report. The region would benefit from developing the benchmarking capability required to chart progress toward high-performance economic and environmental goals on an ongoing basis. This could be done through a partnership among business, academia, policy experts, environmentalists, bank economists, and government specialists in the region.
- **Capitalize on the Devolution of Authority from the Federal Government to the States:** The devolution of power from the federal government to the states offers a unique opportunity to carry out the high-performance reform agenda proposed here. In a worst case scenario, states would assume the reins of power and simply maintain the status quo. A more progressive scenario would involve establishing a high-performance framework of highly integrated

economic and environmental policies. To that end, state policy-makers would do well to borrow a page from the Total Quality Movement and establish a shared vision and benchmarks for success. This process should be transparent and high profile, allowing the public an opportunity to understand the reform effort, buy-in to it and follow its progress.

- **Extend the High-performance Revolution through Redevelopment of Brownfield Sites:** The Great Lakes' region and basin is littered with contaminated brownfield sites - which are a reminder of the environmental legacy of the old mass production age. These sites not only mar the industrial and environmental landscape of the region, they serve to constrain further economic growth and transformation. Frequently, because brownfield sites are in older urban areas, their redevelopment can serve as a catalyst for extending the high-performance revolution to distressed and marginalized areas. Quad Graphics, one of the companies profiled in this report, has begun this process of transformation, redeveloping an old, abandoned site in urban Milwaukee into a site for a clean, high-performance factory. In fact the redevelopment of brownfield sites for high-performance production is a natural next step in the high-performance revival of the Great Lakes' region. In his remarks to the Second World Congress on Zero Emissions, DuPont CEO, Earl Woolard, challenged both corporations and governments to complete the elimination of waste by extending the concept of zero emissions to include zero greenfield development and the redevelopment of older, brownfield sites. The individual Great Lakes states, the Council of Great Lakes' Governors, and the Great Lakes Protection Fund should make redeveloping older sites into centers of high-performance production a top priority of their agendas.

Multi-Stakeholder Process Will Help Ensure Success

State government cannot - and should not - structure or implement a reform effort alone. The level of reform required must involve a broad cross section of stakeholders to ensure a high level of creative energy

and a diversity of ideas. Furthermore, a diversity of stakeholders will be needed to support the implementation of a reform agenda. High-performance manufacturers are the engines of this industrial -environmental revolution, and their input and knowledge is badly needed. There is a great deal to be gained from involving them in reshaping and restructuring environmental policies. It is equally important to seek the input and involvement of other key stakeholders, such as academic experts, environmentalists, bank economists and civic associations. The Great Lakes region has a very robust reserve of talent to draw upon.

Because the Great Lakes states share the same economic and environmental base it will be important to conduct problem solving efforts on a regional level. The Great Lakes Governors' history of working together toward a common goal will serve them well in accomplishing the strategies outlined in this report. In addition, the Governors must call upon other stakeholders to share in this regional strategy.

The Great Lakes' Governors should establish a **Great Lakes High-performance Environmental Initiative** - a multi-stakeholder initiative - composed of leading high-performance business, environmental, policy, civic and academic experts to set this process in motion.

Role of the Great Lakes' Protection Fund:

The Great Lakes Protection Fund has played a vital and essential role in the environmental renewal of the Great Lakes basin. The Fund can continue to fulfill its historic mission and can also play a central role connecting the economic and environmental revival of the Great Lakes basin and region. To do so, it should consider devoting a significant share of its actions to playing the role of "venture capitalist" in the transformation - providing equity funds that will "pay-back" on investments by stimulating the transition to economic and environmental renewal. The Fund can also play a role by supporting the monitoring, analysis and timely evaluation of the costs and benefits of this process and convening key stakeholder groups to constructively debate and reach consensus on strategies and actions.

The high-performance revolution can - and is - being leveraged for environmental ends. The efforts of firms to improve manufacturing processes and increase productivity are opening up new opportunities for environmental improvement for the Great Lakes region and basin. The adoption of high-performance manufacturing, which has helped to revitalize the region's manufacturing base, is creating incentives for innovative pollution prevention strategies and environmentally-conscious manufacturing. The region's growing base of highly innovative, high-performance firms are leaders in the race to improve industrial productivity and reduce environmental costs and risks.

The high-performance revolution is ushering in a whole new paradigm for regional growth and development. The pursuit of zero defect and zero inventory manufacturing strategies is generating substantial environmental benefits, leading toward zero emission production.

The Great Lakes region is on the cusp of this new high-performance paradigm revolving around zero defects, zero inventory, and zero emissions. By linking the region's environmental strategy to its high-performance competitiveness agenda, the region can continue to improve its environmental quality, while strengthening its manufacturing base, increasing its trade, attracting investment from the world's leading companies, and, most of all, securing long-run economic growth for its workers, citizens, and communities.

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