



Introduction to the Compendium on Strategic Environmental Management

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In management schools in the U.S. and throughout the world, the capstone business course is one in business policy or business strategy. This course is taught at both the undergraduate and graduate level. It tries to bring together what students have learned in their other functional courses (accounting, finance, marketing, and operations) and impart a new level of awareness and sophistication in the area of general management.

There are many texts in the area, and there has been much development of other instructional material. Pollution prevention (P2) concepts are almost never incorporated into capstone courses, nor is there usually much mention made of any other environmental topic. This deficiency is lamentable since some of the core concepts of strategy are amenable to treatment from a P2 perspective. The aims of this compendium, therefore, are to show how the most salient topics in strategy, such as competitive analysis and portfolio analysis, can be taught from a P2 perspective. After briefly defining strategic environmental management (SEM), we discuss its effect on competitiveness, how to implement it, and tools for carrying it out.

This compendium's *Resource List* cites relevant books, articles, and websites by topic; those materials are described in the *Annotated Bibliography*, which is arranged alphabetically. Our collection of *Syllabi* show you how four of your colleagues have integrated environmental topics into their management courses. Contact information for these and other mentor faculty appears in the *Resource List*.

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Defining SEM

Business strategy is about achieving competitive advantage. The resource-based view of the firm finds advantage in the creation of firm-specific, distinctive (nonimitable, rare, and nonsubstitutable) competencies. To lower costs, firms can develop such competencies in pollution prevention and continuous improvement; to differentiate their products, they can work on product stewardship and life cycle analysis. They also can commit to a vision of minimal environmental impact as a criterion for entering and exiting businesses.

To understand what we mean by strategic environmental management, see “Note on SEM,” on p. 5, and Stuart Hart’s article, “A Natural-Resource-Based View of the Firm” (*Academy of Management Review* 20, no. 4, October 1995: 986–1,014).

Competitive Analysis

Though these elements are connected and in management develop together, a business strategy is typically divided into formulation and implementation. The aim of formulation is to position the organization such that it can best deliver valuable and distinctive products and services to customers. Value and distinctiveness usually are defined in terms of two attributes: price and quality. The organization strives to become the lowest cost provider of the product or service, or it strives to become the highest quality provider of this product or service.

Organizationally, it is difficult to implement both strategies simultaneously. An untenable position in the long run is to be “stuck-in-the-middle,” since the organizational qualities needed for low cost (e.g., tight hierarchical control) are not compatible with the organizational qualities needed for high quality (e.g., employee participation). Whether this assumption is true in all cases is an empirical question. Organizations commonly are found that combine these attributes, but at the level of general principle, strategy courses usually start with the assumption that sustained competitive advantage is achieved by delivering valuable products and services that cannot be easily imitated and replaced by competitors. By applying the lessons of pollution prevention in a strategically sound manner, managers can strive to make environmentally beneficial steps more profitable.

For background on competitive analysis, we provide a note, “Competitive Analysis: Key Concepts,” on pp. 6–8.

The Low-Cost Strategy

Pollution prevention strategies that lower a company's costs are key to the low-cost strategy. 3M is the world's innovator in creating P2 programs — it started in 1975 and has nearly two decades of success. Polaroid and Dow adopted their programs at the end of the '80s, after passage of the Toxic Reduction Act with its mandatory reporting on use and disposition of hazardous chemicals.

Case studies of all three companies show the importance of organizational incentives and culture. Polaroid had much more trouble than Dow in getting its program up and running. Students should compare the start of each company's P2 program to understand the obstacles and methods for overcoming them. Also important are the lessons of the 3M case.

To illustrate how P2 can lower a company's costs, we suggest the following case materials: “How 3M Makes Pollution Prevention Pay Big Dividends” (T. Zosel, *Pollution Prevention Review*; Winter 1990–91: 67–72) and “Dow Chemical: Environmental Policy and Practice,” Ch. 3-4, and “Polaroid's Toxic Use and Waste Reduction Program,” Ch. 3-3 (both in *Managing Environmental Issues: A Case Book*, ed. R. Buchholz, A. Marcus, and J. Post; New York: Prentice Hall, 1992). We also provide two Student Assignments based on these cases: #1, “Reducing Resource Use and Waste Per Unit of Production”, and #2, “The 7 S's.”

The High-Value Strategy

A key to the high value (premium price) strategy is the capacity to develop new products and services that cannot be matched by competitors. Often, this depends on technological innovations and applications. But being first to the market does not always guarantee success, especially with products that prevent pollution but may be too far out in front of customer tastes.

Ringer produces pesticides and lawn-and-garden products that prevent pollution by using alternative processes. Despite having what appear to be superior products, Ringer has problems gaining market acceptance and becoming profitable. Osmonics, on the other hand, successfully manufactures and sells filtration devices and equipment around the world; they are used to recycle materials in manufacturing processes and thus play a major role in pollution prevention in industries as diverse as electroplating and dairies. Why is Ringer unsuccessful, while Osmonics is successful?

The third case, Deluxe Printing, is about a 1995 winner of Minnesota's Governor's Award for Excellence in Pollution Prevention. The largest checkprinting company in the world, Deluxe won the award for its development of PrintWise, a radically new, entirely pollution-free ink (unlike soy inks, which still use some petroleum byproducts). This case shows how a company can try to convert the constraints of pollution control into opportunities. However, Deluxe still must successfully market this product. Though it has the capacity to revolutionize its industry as well as completely transform itself (it never in the past has manufactured or sold ink), the challenges it faces are difficult ones to overcome.

Students should imagine a portfolio of possibilities. There are some green businesses ("green stars") that are profitable. Others ("green question marks") are not; Ringer is in this latter category. Businesses that are neither environmentally friendly nor profitable ("black dogs") have little future and should be liquidated if possible. Finally, there are some profitable businesses that are not environmentally friendly ("black question marks"). They should be salvaged, but their long-term future can be guaranteed only if their black features can be reduced or eliminated.

To illustrate the use of the high-value strategy, we provide case materials on Ringer, Osmonics, and Deluxe Printing along with Student Assignment #3, "Analyzing Environmental Aspects of Business."

Portfolio Analysis: Investing in Promising Businesses and Exiting From Unpromising Ones

Some of the other cases suggested in this compendium focus on black question marks: companies like DuPont, Dow, and Polaroid have profitable operations that have to become more environmentally friendly. The Ringer and Deluxe cases, and to an extent the Osmonics case, deal with green products whose profitability has to be established or guaranteed:

- Ringer is the start-up company.
- Deluxe is an established firm in a different business that has developed an environmentally friendly product outside its normal sphere of competence.
- Osmonics is an established firm with a long track record in environmentally friendly businesses that is constantly looking for new environmentally friendly businesses to acquire.

By analyzing all these cases, students should gain experience in the full range of business situations that business strategists interested in strategic environmental management can face. Portfolio analysis typically is done with an appraisal of industry conditions (using such indicators as industry growth) and company strengths (using such indicators as market share). Investment is called for in products and businesses where the industry is growing and the company is strong. Contraction and liquidation are the best moves when the opposite conditions prevail. The challenge is managing when industry conditions are strong, but company position is weak, or when company position is strong in a declining industry. We introduce an environmental component to this type of analysis, suggesting that it is in a company's long-run best interest, because of issues like liability and growing regulation, to also examine the environmental impact of a product or business.

To illustrate eco-integrated portfolio analysis, use Student Assignment #4. We also suggest you read "Du Pont and the Clean Air Act of 1990" (M. Jankus, in *Business and Society: Strategy, Ethics, and the Global Economy*, ed. A. Marcus; Chicago: Irwin, 1996, 94-105) and Stuart L. Hart's "Beyond Greening: Strategies for a Sustainable World" (*Harvard Business Review* 75, no. 1; January-February 1997: 67-76; reprint available from HBSP: 800/545-7685 or custserv@hbs.harvard.edu).

SEM and Competitiveness

Can the environment really benefit a company by leading to innovative solutions that lower costs and increase product value? A growing controversy has arisen around this question. Michael Porter and Claas van der Linde have argued that environmentally sound management can be beneficial for both the environment and for business. This point of view has been challenged by the consultants Noah Walley and Bradley Whitehead. The *Harvard Business Review* then held a symposium on this topic with responses from a variety of participants.

To illustrate this controversy, we suggest two articles: Porter and van der Linde's "Green and Competitive," *HBR* 73, no. 5 (September-October 1995): 120-134; and Walley and Whitehead's "The Challenge of Going Green," *HBR* 72, no. 3 (May-June 1994): 46-50. To order reprints, contact Harvard Business School Publishing directly (call 800/545-7685 or send e-mail to custserv@hbs.harvard.edu).

Implementing SEM

While there often may be economic advantage from introducing environmentally sound practices, implementing them within the firm may take transformational leadership or shocks, jolts, and crises that threaten an organization's survival before new practices are adopted. To encourage innovation, inflexible, media-based regulation has to change.

For a discussion of some of these implementation issues, see our note on pp. 9-12, "Pollution Prevention—Overcoming Barriers to Further Progress."

Sources:

Freeman, R. Edward. *Strategic Management: A Stakeholder Approach*. Boston: Pitman, 1984.

Ghemawat, Pankaj. "Sustainable Advantage." *Harvard Business Review* 64, no. 5 (September-October 1986): 53-58.

Hamel, Gary, Yves Doz, and C. K. Prahalad. "Collaborate With Your Competitors and Win." *Harvard Business Review* 67, no. 1 (January-February 1989): 134-139.

Hamel, Gary, and C. K. Prahalad. "Do You Really Have a Global Strategy?" *Harvard Business Review* 63, no. 4 (July-August 1985): 139-148.

Tools for SEM

Tools for implementing P2 are very well-developed. There are many manuals and other technical sources. Methods that have been developed include:

- financial analysis for P2
- environmental accounting
- material balance models
- environmental impact assessment
- total quality environmental management
- benchmarking
- design for the environment
- life-cycle analysis
- environmentally conscious manufacturing
- green marketing
- eco-integrated portfolio analysis

Standard waste minimization and pollution prevention methods such as materials balance analysis show how costs can be lowered by means such as tightening production processes and eliminating leaks and changing product qualities and production processes. The high value strategy depends on verifying environmental claims by using tools like life-cycle analyses. In addition to covering the other main topics in this introduction, this comendium's Annotated Bibliography summarizes some of the important material on tools as well as additional cases from the Harvard Business School and other publishers.

———. "Strategic Intent." *Harvard Business Review* 67, no. 3 (May-June 1989): 63-76.

Hill, Charles, and Gareth Jones. *Strategic Management: An Integrated Approach*. Boston: Houghton Mifflin, 1989.

Oster, Sharon. *Modern Competitive Analysis*, 2d ed. New York: Oxford University Press, 1994.

Porter, Michael. "How Competitive Forces Shape Strategy." *Harvard Business Review* 57, no. 2 (March-April 1979): 137-145.

Prahalad, C. K., and Gary Hamel. "The Core Competence of the Corporation." *Harvard Business Review* 68 (May-June 1990): 79-91.

What Is SEM?

Strategic environmental management is the positioning of a business to take advantage of environmental challenges. It is the attempt to make these challenges into profit-making opportunities rather than threats that curtail business operations and prospects. Various companies have created value-adding programs in response to environmental issues. A list of some of the actions they have taken follows:

STRATEGY AND ORGANIZATION

- Cut back on environmentally unsafe operations.
- Carry out R&D on environmentally safe activities.
- Develop and expand environmental cleanup services.
- Compensate for environmentally risky endeavors.
- Purchase environmentally safe businesses.
- Change structure, compensation, and other systems.

PUBLIC AFFAIRS

- Try to avoid losses caused by appearing insensitive to environmental issues.
- Attempt to gain environmental legitimacy and credibility.
- Collaborate with environmentalists.

LEGAL

- Try to prevent confrontation with pollution control agencies.
- Comply early.
- Take advantage of innovative compliance programs.
- Rely on self-regulation rather than government requirements.

OPERATIONS

- Promote new manufacturing technologies.
- Encourage technological advances that reduce pollution from products and manufacturing processes.
- Modify production equipment and change manufacturing operations.
- Eliminate manufacturing wastes.
- Try to find alternative uses for wastes.
- Recycle wastes.

MARKETING

- Tell the truth, the whole truth, and nothing but the truth about your products' environmentally friendly features; avoid being attacked for unsubstantiated or inappropriate claims.
- Create consumer desire for environmentally friendly products as well as researching this market.

ACCOUNTING

- Demonstrate that anti-pollution programs pay.
- Show all affects of pollution reduction programs.

FINANCE

- Gain the respect of the environmentally concerned investment community.
- Recognize true liability.
- Recognize business opportunities.

Source: Buchholz, Rogene, Alfred Marcus, and James Post. *Managing Environmental Issues: A Casebook*. New York: Prentice-Hall, 1992.

Competitive Analysis: Key Concepts

In examining a company's external strengths and weaknesses, it is necessary to go beyond broad contextual factors (the macroeconomy, technology, social and demographic changes, law and politics) and examine the specific industry setting (Oster, 235).

An industry is a group of companies offering products or services that are close substitutes for each other (products that satisfy the same basic needs). For example, the metal and plastic body panels used in auto assembly are close substitutes for each other.

Michael Porter has developed a framework for analyzing the competitive forces in an industry setting to identify the opportunities and threats that confront a company (Porter, 1980, p. 5). The framework focuses on five forces:

1. Risk of new entry by potential competitors
2. Threat of substitute products
3. Degree of rivalry among established companies within the industry
4. Bargaining power of suppliers
5. Bargaining power of buyers

The stronger each of these elements, the it limits established companies' profits. A strong competitive force is a threat since it depresses profits. A weak competitive force is an opportunity, because it allows greater profits. The strength of the five forces changes over time as industries evolve.

Structural change in an industry is accompanied by changes in industry boundaries. Government may affect this structural change, for example through the regulation of product quality and safety and environmental quality.

New entrants and substitute products respond to opportunities created by government. They can change industry structure, threatening the dominant players and compelling them to fight back.

Ultimately, consumers decide which products to use. Their decisions may be based on many factors. Some of the most important are cost and performance advantages of rival products and degree to which the advantages are obvious and certain.

PRODUCT MARKETING POSITIONING

Theodore Levitt in his book *The Marketing Imagination* (New York: Free Press, 1986) has written:

Profit is a meaningless statement of corporate purpose. Without customers in sufficient and steady numbers there is no business and no profit. No business can function effectively without a clear view of how to get customers, what its prospective customers want and need, what options competitors give them, and without explicit strategies and program focused on what goes on in the marketplace.

Positioning is the choice of target markets and the design of a marketing mix to create a differential advantage in these markets.

Consumers perceive products in a market based on multiple attributes. In undifferentiated marketing, a single type of product is offered to everyone. This may not succeed because the demands of the different segments are different. Focused marketing emphasizes a single segment, while differentiated marketing calls for a different marketing mix for each segment.

Ford's Model T was an example of undifferentiated marketing. Only one color was offered all consumers: black. The early success of General Motors was based on segmenting the market based on different classes of customers and providing products with different attributes for each class. Rolls Royce, on the other hand, has adhered to a focused strategy, making cars for only one segment of the market.

The market for personal computers is another example of market segmentation. There are different segments — for scientific users, office users, educational users, home users, and so on. Each segment requires different features (e.g., scientific users may require functions that others do not need). Distribution channels, advertising, promotion, and pricing all will vary.

Zenith, for instance, has been most successful in the educational segment by offering 40% discounts to colleges and universities and by giving away free software as a promotional tool. IBM has done well in the business segment by capitalizing on its reputation and its large sales force. Hewlett-Packard has done best in the scientific segment by designing its machines to meet the needs of scientists and engineers.

A differential advantage is achieved by making distinctive products for the market segments a company serves. The segment advantage may be created by different elements in the marketing mix: lower prices, a superior product or better design, strong service after sale, more creative advertising or promotion, and so on.

GENERIC STRATEGIES

Porter's generic strategies are overall cost leadership, differentiation, and focus (Porter, 1980, p. 39).

Overall cost leadership requires aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight costs and overhead control, avoidance of marginal customer accounts, and cost minimization in areas like R&D, service, sales force, advertising, etc.

The skills and resources needed for overall cost leadership are substantial capital investment and access to capital, process engineering skills, intensive supervision of labor, products designed for ease in manufacture, and low-cost distribution system.

The organizational requirements are tight cost control, frequent, detailed control reports; structured organization and responsibilities; and incentives based on meeting strict quantitative targets.

Differentiation calls for the creation of something that is perceived overall in the industry as being unique. Approaches to differentiation can take many forms: design or brand image, technology, features, customer service, dealer network, or other dimensions.

The skills and resources needed for differentiation are strong marketing abilities, product engineering, creative flair, strong capability in basic research, corporate reputation for quality or technological leadership, unique skill combinations, and strong cooperation from marketing, distribution, and supply channels.

The organizational needs are strong coordination among functions in R&D, product development, and marketing; subjective measurement and incentives instead of quantitative measures; and amenities to attract highly skilled labor, scientists, or creative people.

Focus consists of concentrating on a particular buyer group, segment of the product-line, or geographic market. It can rely on either a low-cost or differentiation strategy, but with a particular target group in mind.

Uniqueness

Porter believes that, to achieve sustained competitive advantage, a company must have a unique strategy. It cannot be "stuck in the middle." According to Porter, factors that lead to uniqueness include:

- special product features and performance
- services provided (credit, delivery, repair, etc.)
- content of an activity (for instance, the information provided in order processing)
- intensity of an activity (such as rate of advertising spending)
- technology employed in performing an activity (e.g., precision of machine tools, computerization of order processing)
- quality of inputs procured for an activity
- procedures governing personnel (service procedures, nature of sales calls, frequency of inspection or handling, etc.)
- skill, experience level, and training of personnel
- information to control an activity (for example, the number of temperature, pressure, and variables used to control a chemical reaction)

DISTINCTIVE COMPETENCE & THE VALUE CHAIN

A *distinctive competence* is a company strength that competitors cannot easily imitate. For example, Caterpillar has used a distinctive competence for distribution and after-sales service to maintain buyer loyalty and protect its market share. 3M has relied upon its strengths in research and development and innovation to build its sales and profits.

Distinctive competences typically are found within the individual functions of a company — functions such as marketing, manufacturing, and materials management. Companies should create distinctive competences in the functional areas and correct weaknesses (Hill and Jones, 119–120).

The *value chain* is a device to show how value can be created in the functional areas (Porter, 37).

Primary activities have to do with the physical creation of the product, its marketing and delivery to buyers, and after-sale service:

1. **inbound logistics** — receiving, storing, and disseminating inputs to the product.
2. **operations** — transforming inputs into final product form.
3. **outbound logistics** — collecting, storing, and physically distributing the product to buyers.
4. **marketing and sales** — providing the means by which buyers can purchase the product.
5. **service** — providing the means which enhance or maintain the value of the product (such as installation, repair, training, parts supply, etc.)

Support activities are:

1. **procurement** — purchasing the inputs to be used in the value chain.
2. **technology development** — making efforts to improve the product and process.
3. **human resource management** — recruiting, hiring, firing, training, developing, and compensating employees.
4. **administration** — planning, financing, accounting, legal and government affairs, and quality.

Value is a measure of total revenue: the price a firm's product commands times the units it can sell.

- **Creating value** for buyers that exceeds the costs of doing so is the purpose of any strategy.
- **Margin** is the difference between total value and the cost of performing activities.
- **Comparing the value chains** of competitors in an industry reveals the differences that determine competitive advantage.

The ways activities are performed determine if a product is high- or low-cost relative to competitors and if the product has a special differentiating feature.

Sources:

Hill, Charles, and Gareth Jones. *Strategic Management: An Integrated Approach*. Boston: Houghton Mifflin, 1989.

Oster, Sharon. *Modern Competitive Analysis*, 2d ed. New York: Oxford University Press, 1994.

Porter, Michael E. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press, 1980.

———. *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press, 1985.

Pollution Prevention: Overcoming Barriers to Progress

In theory, the concept of pollution prevention (P2) — reducing potential pollution at input rather than output — makes good economic sense. Its goal is waste reduction: by increasing throughput, lowering rework rates and scrap, and using less material and energy per unit of production, it allows a company to save money, enhance efficiency, and become more competitive.

P2 also has the potential to reduce a company's liability for potential environmental harms and damage. In addition, it can help companies more effectively meet regulatory standards and reduce exposure to negative publicity under government reporting requirements. Clearly, there are many cases where P2 should be a win-win situation for both the company and the environment, or at least a situation where a company meets environmental protection goals at lower costs than by resorting to end-of-pipe remedies.

Then why has P2 stalled? Why, despite impressive initiatives by some companies, has it not been more widely adopted? We believe that there are four major reasons:

- 1.Despite financial benefits, many managers view P2 as an extension of existing regulatory programs that they regard as costly and burdensome.
- 2.Environmental accounting systems are still inadequate to measure the costs and savings of P2 programs.
- 3.P2 involves changing production processes, which introduces risks that some plant managers, understandably, are reluctant to take.
- 4.Investments in waste reduction programs compete with other demands on capital that are thought by management to be of more strategic importance. Top management of many companies, while supporting the concept of P2, is not involved closely enough in promoting its implementation.

P2 AS AN EXTENSION OF COSTLY AND BURDENSOME REGULATORY PROGRAMS

To the detriment of P2, compliance problems tend to take up a great deal of environmental and plant managers' time. Regulations keep changing. Managers feel that so much effort has to go into keeping up with regulatory requirements that they have no time left for P2.

Regulated companies often must meet stricter new emission limits over a short time period. P2 solutions that can achieve rapid compliance, however, involve risks to production. The regulated community can take these risks only if regulations are phased in more gradually.

In contrast, managers of European companies tend to be less compliance-driven and more P2-focused. This is encouraged by the more stable and flexible regulatory structure there. In the long run, this difference will give competitive advantage to the European economy.

Many U.S. managers believe that emission limits are too rigid and often rule out cost-effective P2 solutions. For instance, a solution might substantially decrease the release of several kinds of harmful emissions below today's standards, but at the price of slightly raising levels of less harmful pollutants above allowed levels. This is prohibited under existing laws, although it would benefit both the economy and the environment.

One of the potential benefits of a P2 investment is that by reducing the emissions of pollutants sufficiently at the source, a company can meet or even exceed compliance requirements without having to invest in costly end-of-pipe technologies. Existing regulations that insist on the employment of "best available control technology," however, can force the company to make expenditures that will greatly reduce or eliminate the gains projected from the P2 project.

Another problem that U.S. managers note is that each new P2 project appears to require the renegotiation of a plant's permits. This adds risks to the project and burdensome paperwork in areas that had seemed settled.

Still another concern raised by U.S. managers is that the government has defined P2 in a way that excludes recycling and reclamation. Many interesting options cannot be considered because of this definition.

While these issues just touch the surface, they reveal an underlying unease that exists because the boundaries between compliance and prevention have not been acceptably clarified. Too much of the emphasis remains on compliance; not enough leeway has been given for the innovative solutions that come into play with P2.

INADEQUATE ACCOUNTING SYSTEMS

There aren't many accounting systems that measure the costs and savings of P2 programs. Government can help by encouraging the creation of the accounting measures (e.g., U.S. EPA's ongoing workshop on accounting and capital budgeting). Without better accounting mechanisms, most companies are unable to accurately measure the costs and savings of P2. According to a survey by *Chemical Engineering*, 60 percent of plant managers could give no estimates of the savings from their P2 programs, and 33 percent were unable to give the total amounts spent on P2.

Traditional accounting methods would assign all environmentally related spending on production to the cost of goods sold. A P2 project may give rise to an increase in easily identified direct production costs but at the same time reduce raw materials costs and waste disposal costs that do not get properly assigned to the project. Finally, the added costs of implementing the P2 innovation are clearly defined, but the resulting savings need verification by actual plant operation. Since many other variables are changing at the same time, it is hard to isolate the savings engendered by P2.

"Total Cost Accounting" (TCA) would incorporate these savings directly. TCA requires the projection of future environmental and safety liabilities whose present value would be included in total costs. That is a very iffy proposition, however, and adds to the reluctance of management to adopt changes like TCA. Nevertheless, encouraged by the U.S. EPA, movement is progressing along these lines.

A sensible TCA would also project future environmental regulations, since historically these have almost always gotten stricter. Although new scientific knowledge could change emission limits in unpredictable ways, government should nevertheless give signals about the directions such projections might take by trying to set realistic and firm long-term goals for pollution control. A P2 project may be transformed from one of little net payoff to a desirable investment if higher *projected* end-of-pipe cleanup costs are included in the analysis.

Another option, "Activity-Based Accounting," tries to break down accounts by product and would be ideal for analyzing plant- and product-specific P2 projects. The claim, however, is that this is too costly to install and is time-consuming.

THE RISK OF CHANGING PRODUCTION PROCESSES

P2 involves changing production processes. This introduces risk that many plant managers are, understandably, reluctant to take. Most plant managers have a great deal of autonomy, and their performance is often measured solely by the cost and quality of the facility's final product.

Senior management must get involved in P2 efforts, set clear goals, and monitor progress. Plant managers have to be evaluated by how they meet environmentally based goals as well as production-based goals.

Full environmental cost accounting would properly assign these costs to a particular plant manager's operations and eliminate the false distinction between meeting profit and environmental goals. A successful P2 program would fit into and be part of the process of continuous improvements—small incremental changes that are arrived at carefully with the help of operating experience and full cooperation and contribution from all of the plant employees.

TOP MANAGEMENT COMMITMENT

We think strategic management issues are playing a role in how successfully the P2 approach is being introduced into U.S. manufacturing. Even P2 projects with projected rates of return considerably higher than a company's hurdle rate sometimes fail to gain approval from top management's capital budgeting committee.

In this highly competitive environment, strategic investments related to keeping or gaining market share will get precedence even if the promised returns are far less than promised by the laudable but only "tactical" P2 program. Perhaps top management is simply not interested enough in small, environmentally related (or even other) investments but is unwilling to delegate the budgeting of such projects to lower management levels.

Extending the Boundaries of P2

We also raise the issue that government P2 programs (e.g., the Toxic Reduction Inventory) do not sufficiently account for all the emissions resulting from the making of a final product. Such programs arbitrarily confine emissions to what happens at a plant or related plants of a single company, disregarding what takes place upstream or downstream from the production process.

Many of the suppliers of large manufacturing companies are small businesses that find compliance of environmental regulations a disproportionately larger financial burden. The enforcement of pollution limits for small companies is a significant problem in Minnesota and elsewhere.

If we can define the total level of pollutants emitted by all sources in the manufacture of a product, lower-cost options will arise of reducing these total emissions by having the manufacturer assist and invest in both P2 and controls at its suppliers' facilities. The manufacturer would then be credited with these reductions and, under a revised set of laws and regulations, be permitted to defer the installation of more costly systems at his/her own facilities.

The manufacturer's suppliers of energy are not small companies; electrical energy suppliers in particular have large and costly compliance requirements. Yet the investment in greater energy efficiency by the manufacturer is not included in the definition of P2. This makes no sense, especially in light of the need to meet reduced CO₂ goals. Should incentives based on lowered pollution due to energy efficiency be offered as part of government-sponsored P2 programs?

Company Profitability

In summary, if pollution prevention is going to work, it must enhance a company's profitability. Environmental protection is costly. According to *Chemical Engineering's* November 1993 survey of U.S. chemical industry plant managers, an average of 18% of plant budgets go to meet environmental regulations. A successful system of the future for environmental regulation must encourage and reward innovation and self-policing by business. P2 is an important component of that new system, but there are some significant problems that are impeding its full implementation.



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The mission of the NPPC is to promote sustainable development by educating students, faculty, and professionals about pollution prevention; create educational materials; provide tools and strategies for addressing relevant environmental problems; and establish a national network of pollution prevention educators.

In addition to developing educational materials and conducting research, the NPPC also offers an internship program, professional education and training, and conferences.

The NPPC provides information on its programs and educational materials through the Internet's Worldwide Web; our URL is <http://www.umich.edu/~nppcpub/> Please contact us if you have comments about our online resources or suggestions for publicizing our materials through the Internet. Thank you!