Annotated Bibliography of IE/OR-Related Pollution Prevention Sources

For information on obtaining many of the sources listed here, see the Resource List, which is arranged by publication type. Bracketed abbreviations indicate the IE/OR subdiscipline(s) to which each document is relevant: General [G], Decision Analysis [DA], Facilities Planning [FP], Operations Research [OR], Production Control [PC], Total Quality Management [TQM], Capital Budgeting [CB], and Organizational Design/Management of Change [OD/MC]. This information is also shown in the matrix at the end of this document.

Alm, Alvin L. "Pollution Prevention and TQM." *Environmental Science and Technology*, 26 (1992): 452.

The author discusses the conceptual similarities of TQM and pollution prevention. He calls on environmental professionals to embrace TQM, and calls on companies with existing TQM programs to embrace pollution prevention. [TQM]

Amoco Corporation. *Second Victory at Yorktown.* 1993.

This 30-minute video documents the cooperative project between Amoco and the EPA to explore pollution reduction at a petroleum refinery. The results of the project have important implications for both engineering and business.

Amoco Corporation and the University of Michigan. "Amoco and the Environmental Decision Analysis." NPPC, 1995.

Investigates Amoco's use of the Analytical Hierarchy Process in a pollution prevention project at its Yorktown refinery. Includes discussion questions.

Ausubel, Jesse H., and Hedy E. Sladovich. *Technology and the Environment*, pp. 143–252. Washington: National Academy Press, 1989.

Under the subject titles of "Industrial Metabolism," "Dematerialization," and "Regularities in Technological Development," this book presents the concept of how technology interacts with the environment. While the material is somewhat technical in nature, the systems approach to environmental problems makes it relevant to industrial engineering. Production processes are reviewed to identify associated environmental problems. The authors discuss the use of technology to solve environmental problems, specific opportunities to use technology, and the importance of educating current and future engineers and managing technological change in employing this technology. The tone of the book tends toward the "technology can solve all our problems" side of the debate. [OD/MC][PC]

Bender, Paul S., William D. Northup, and Jeremy F. Shapiro. "Practical Modeling for Resource Management." *Harvard Business Review* 60 (March/April 1981): 163–173.

International Paper is the world's largest manufacturer of paper products. Managing these resources is clearly a formidable task. The authors discuss the successful design, implementation and use of a practical modeling system to manage these resources. Implicit in this model is the requirement to minimize waste. [DA][OR]

Berglund, R.L., and C.T. Lawson. "Preventing Pollution in the CPI." *Chemical Engineering* 98 (September 1991): 120–127.

This article provides a thorough review of the components of pollution prevention in the chemical process industries (CPI). Successful pollution prevention programs demand the attention to eight aspects of a manufacturing operation: product design, process design, plant configuration, information and control systems, human resources, research and development, suppliers' role and relationship, and organization. [G]

Bodily, Sam. "Armco Inc.—The Bubble Policy" (Report #UVA-QA-227). Charlottesville, VA: Darden Graduate School of Business (University of Virginia), 1982.

This case employs a simplified linear programming model to evaluate operating and capital investment options under the "bubble policy" method for measuring air pollution emissions. [OR]

Brown, Lester. *Building a Sustainable Society*, pp. 284–348. New York: Norton, 1981.

The author first discusses the effects of industrialization on the environment. He then identifies social and economic strategies for sustainable development. Of these strategies, changing social values and altering the role of business are particularly relevant to organizational design; the strategies relevant to production control include alternative energy sources and altering the role of business. [OD/MC][PC]

Burall, Paul. *Green Design.* London: The Design Council, 1991.

This book is a reference for the use of environmentally considerate materials and technologies. The specific industrial examples about material substitution, recycling, packaging and energy use, and efficiency are relevant to facilities planning; the author looks at motivation and management of technological change as it relates to implementing these technologies. [FP][OD/MC]

Cairncross, Frances. *Costing the Earth*, 143–252. London: The Economist Books, 1991.

This book looks at the unique environmental challenges facing business and government today. The shortcomings of contemporary accounting methods and process control techniques in dealing with environmental issues are explored in detail. The author shows that internalizing environmental costs can lead to prosperity. To this end, a "green" checklist is provided for industry. Similar to quality checklists in many ways, this checklist includes management-of-change elements managers should employ as well as factors for consideration in production control. The author also provides data for societal costs of pollution and the value of natural resources that go unused. [OD/MC][PC][TQM]

Caplan, Darlene W. "Sylvania's GTE Products Problem Stoppers: #1 Employee Involvement Team." *Total Quality Environmental Management* 2 (Winter 1992/93): 159–164.

The article discusses the winner of the 1992 Association for Quality and Participation's National Team Excellence Competition. A nine-person work team called the Problem Solvers from Sylvania Lighting in York, Pennsylvania, won for eliminating glass waste at York by recycling it in the plant. [TQM][OD/MC]

Chechile, Richard A., and Susan Carlisle. *Environmental Decision Making.* New York: Van Nostrand Reinhold, 1991.

This book discusses the following topics: psychological factors; ecosystem perspectives; probability, utility and decision trees; factoring risk; the economic model; resource allocation; ethical aspects; public policy decision making; regulatory decisions; and international decision making. Of particular interest to industrial engineers are the introductory chapter (which expands the currently used elements of the decision making process to include costs external to the decision-maker), and the use of utility theory in environmental decision making. [DA]

Cramer, J.M., and B. Roes. "Total Employee Involvement: Measures for Success." *Total Quality Environmental Management* 3 (Autumn 1993): 39–52.

Whether environmental management is successful depends partly on whether managers can actively involve employees in policy formulation and implementation. This not only generates shop-floor support for environmental policy, it also makes use of employees' environmental knowledge and expertise. [OD/MC][TQM]

Dauncey, Guy. "How Green Is Your Company?—A Corporate 'Green Rating.'" In *Green Business: Hope or Hoax?* edited by Christopher Plant and Judith Plant, 66–70. Philadelphia: New Society, 1991.

Describes how a company can set up a framework for judging its "greenness": (1) establish cross-departmental "environmental action teams"; (2) appoint an "environmental vice-president" with responsibility to improve the company's environmental profile; (3) commission an environmental audit; (4) develop staff and customer questionnaires to solicit company actions and products; (5) hold cross-company environmental hearings to engage staff; and (6) instruct each department to develop an environmental plan. Includes examples. Such material is easily adapted to quality audit programs. [TQM]

Deland, Michael R. "An Ounce of Prevention . . . After 20 Years of Cure." *Environmental Science and Technology*, 25 (1991): 4.

As chair of the President's Council on Environmental Quality under George Bush, Deland writes on why business should embrace P2. He argues that companies should implement pollution prevention because of cost and regulatory advantages in addition to protecting future generations of workers; he also suggests applying TQM methods to implement pollution prevention programs. Although from a previous administration, the article still provides a good look at the government's perspective. [G][TQM]

Early, William F., and Mark A. Eldson. "Design for Zero Releases." *Hydrocarbon Processing* 69 (August 1990): 47–49.

Provides methods for incorporating environmental issues into chemical facility design. (This article is written specifically about chemical manufacturing processes and design considerations — flanges and welded connections, valves, relief valves, pumps, transfer lines/hoses, installation, and operation — and thus is not recommended for general reading.) [FP]

Evanhoff, Stephan P. "Hazardous Waste Reduction in the Aerospace Industry." *Chemical Engineering Progress* 86 (April 1990): 51–61.

This article outlines the aerospace industry's manufacturing process wastes, explaining the processes used (degreasing, surface finishing painting, surface cleaning, maintenance, transportation, and laboratory R&D) and the wastes generated. It then outlines current recycling and recovery technologies used in the industry. The information describes processes and their chemical and mechanical attributes. While it is too specific for general industrial engineering curricula, it provides a good overview for industrial engineers interested in the aerospace industry.

Feichtinger, G., and M. Luptacik. "Optimal Production and Abatement Policies of a Firm." *European Journal of Operations Research* 29 (1987): 274–285.

This article examines the relationship between the loss of jobs caused by increased environmental regulation and the loss of environmental quality caused by pollution. The authors develop a model that determines an optimal path where pollution control increases as the number of employees rise. [OR]

Freeman, Henry, Teresa Harten, Johnny Springer, Paul Randall, Mary Ann Curran, and Kenneth Stone. "Industrial Pollution Prevention: A Critical Review." *Air and Waste* (Journal of the Air and Waste Management Association) 42, no. 5 (May 1992): 618–656.

A comprehensive review of pollution prevention activities around the country, this article discusses pollution prevention; governmental legislation and programs; industrial programs; pollution prevention assessments and measurement issues; and incentives and barriers to pollution prevention, life cycle analysis, and product design. Identifies and critiques topical material for each topic. A very good reference for gathering comprehensive pollution prevention information. [G][TQM][PC]

Friedlander, Sheldon K. "Pollution Prevention: Implications for Engineering Design, Research and Education." *Environment* 31 (May 1989): 10–15, 36–38.

As pollution prevention and other proactive strategies gain momentum as environmental strategies, engineers are faced with the challenge of developing technological solutions. The author looks at source reduction and product design as they effect research and education. [G]

Frosch, Robert A., and Nicholas E. Gallopoulos. "Strategies for Manufacturing." *Scientific American* 261 (September 1989): 144–152.

The authors present the idea of the "industrial ecosystem" in this article. As natural resources become more scarce, this idea should gain interest in industry. Three "industrial ecosystems" are presented: the production of plastics from petroleum, the conversion of iron ore to steel, and the use of platinum as a catalyst.[G][PC][TQM]

Goldner, Howard J. "Waste Minimization Starts at the Top." *Research and Development Magazine* 33 (September 1991): 48–52.

This article presents the importance of a company's research and development department in bringing about successful pollution prevention projects. Not only should R&D focus on the product, but it should focus on the manufacturing process, as well. To motivate this shift in R&D's orientation, top management must understand the need and benefits of pollution prevention initiatives. [G][OD/MC]

Green, Philip E.J. "Environmental TQM." *Quality Progress* 26 (May 1993): 77–80.

The author stresses that "quality professionals have a tremendous contribution to make. As iconoclasts, they have learned to challenge sacred assumptions and develop new and better ways to work. They have learned to establish credibility for new work and management practices." Deming's 14 points to environmental issues are discussed, as well as benefits to protecting the environment, and altering managers' attitudes. [TQM]

Gregory, Paul, Richard Larson, and Alan Minkoff. "Dirty Work." *OR/MS Today* 19 (June 1992): 34–39.

The authors discuss the increased use of marine transport to dispose of New York City's waste due to closed landfills. To optimize allocation of the garbage barge armada, the authors developed the Barge Operation Systems Simulation. As a result of this model, refuse barges move through New York Harbor more effectively. An issue unanswered by the article is the necessity to reduce the waste generated by New Yorkers. [OR]

Hahn, Robert W. "On Reconciling Conflicting Goals: Applications of Multi-objective Programming." *Operations Research* 32, no. 1 (1984): 221–288.

In most mathematical programming problems, the goal is to minimize cost subject to feasibility constraints and a set of targets. In contrast, multi-objective programming treats the objectives as the choice variables, and cost as a parameter. This article uses the two approaches to analyze a pollution emission problem. The comparison reveals that the traditional cost-minimizing approach can generate solutions that are inefficient, in the sense that greater emissions reductions could have been attained at the same cost. Because the solution sets to the two problems may differ, the author derives conditions under which the two approaches yield a similar set of results. [OR]

Hämälainen, Raimo P. "Decision Analysis Makes Its Way Into Environmental Policy in Finland." *OR/MS Today* (June 1992): 40–43.

The author discusses using decision analysis techniques in developing decisions outside the traditional engineering and business spheres. He then describes his HIPRE decision-support software, which was used to assist the Finnish government in making acid rain policy. [DA]

Harmon, Leith S. "A Logical Role for the Industrial Engineer: Pollution Prevention." NPPC, 1995.

Discusses the inherent and critical role industrial engineers must play in developing successful pollution prevention programs. Explains regulatory and market factors for P2 and outlines a framework for P2 within a firm. Provides accompanying questions and answers. [G]

———. "Pollution Prevention and Facilities Planning." NPPC, 1995.

Discusses the need for facility planners to consciously include environmental considerations when locating and designing facilities. Provides accompanying questions and possible answers. [FP]

———. "Total Quality Management: A Methodology for Pollution Prevention." NPPC, 1995.

Discusses how the four elements of Total Quality Management — customer focus, continuous improvement, teamwork, and strong management commitment — can all be applied to prevent pollution. Provides accompanying questions and possible answers. [TQM]

———. "The Tragedy of the Commons and the Decision Maker." NPPC, 1995.

Investigates the failure of the rational decision model under certain resource allocation conditions. Provides accompanying questions and answers. [DA]

Harmon, Leith S., and Katta Murty. "Pollution Prevention as Continuous Improvement at Ford Motor Company." NPPC, 1995.

Describes Ford's successful use of continuous improvement techniques to reduce waste at its Livonia, MI, Transmission Plant. Discusses a cross-disciplinary team and the waste-prevention opportunities it developed as well as a P2 guidebook that could be used for waste prevention at other Ford plants. Provides accompanying questions, answers, and discussion points. [TQM]

Haynsworth, H.C., and R. Tim Lyons. "Remanufacturing By Design." *Production and Inventory Management* (2nd Quarter 1987): 24–29.

"Design for remanufacturability" is an idea that is gaining ground both here and in Europe. The automotive industry is the primary industry utilizing this strategy. The benefits of using remanufactured parts include increased savings for customers, better performance than reconditioned parts, reduction of capital

spending, and reduced need for raw material. The author points out how this strategy can be incorporated into the product life cycle. Problems include difficulties in developing a collection and distribution network for the used parts, and the perceived quality problem of using "previously used" parts. [PC]

Hethcoat, Henry G. "Minimize Refinery Waste." *Hydrocarbon Processing* 69 (August 1990): 51–54.

This article outlines the petroleum industry's manufacturing processes and their attendant wastes. The author explains the current recycling and recovery technologies (integrated units, in-line bleeding, crude tank mixers, air cooler maximization, demineralized river water, amine degradation prevention) used in the industry. The information describes processes and their chemical and mechanical attributes. While it is too specific for general industrial engineering curricula, it provides a good overview for industrial engineers interested in the petroleum industry.

Hirschhorn, Joel S., and Kirsten U. Oldenburg. *Prosperity Without Pollution.* New York: Van Nostrand Reinhold, 1991.

This comprehensive book looks at the issue of pollution prevention from social, organizational, and industrial management perspectives (in contrast to many pollution prevention guides, which primarily provide a technical perspective). The first half of the book is particularly relevant to production control. Chapter 3, "Achieving Success By Overcoming Obstacles," is pertinant to organizational design and the management of change along with quality management programs. Chapter 4, "Data Tells the Story: Too Much Waste," presents the surprisingly complex issues that surround tracking waste. Chapter 7, "Changing Consumption: Reducing Garbage," discusses how consumers are a factor in the reduction of waste. Chapter 9, "No Time to Waste," discusses public policy responsibilities in pollution prevention. [PC][TQM][OD/MC]

Hocking, Martin B. "Paper vs. Polystyrene: A Complex Choice." *Science* 251 (February 1, 1991): 504–505.

Using life cycle analysis, the author analyzes the environmental effects of paper vs. polystyrene packaging. This article is one of the ground-breaking discussions of life-cycle analysis. While the author concludes that polystyrene is less damaging to the environment for single use situations, recent changes in paper production technology cast doubts on that conclusion today. From an educational standpoint, the significance of this article lies not in the authors conclusions but in his methodology. As such, the article can be used to introduce the *process* of life cycle analysis.

Imbler, C. Clarke. "Who Pays the Price for Environmental Pollution?" *Pollution Engineering* 21 (Sept. 1989): 92–94.

This editorial piece outlines the weaknesses inherent in the many regulatory "solutions" to the country's waste problems. The author discusses how RCRA and Superfund create litigious behavior and do not fully address the true costs of pollution cleanup. This article might be used to make a strong case for pollution prevention: if the waste is not generated, liability under the various regulations will not occur. Total cost accounting (including the expected costs of waste handling, waste disposal, and liability in the capital budgeting process) can make pollution prevention projects appear more economically attractive. [G][CB]

Keeney, Ralph L. "Structuring Objectives for Problems of Public Interest." *Operations Research* 36, no. 3 (May/June 1988): 396–405.

Sustainable development requires that industry view all costs (not just those internal to the firm) of doing business when making decisions. When the environmental issues are included in the business decision process, the set of stakeholders must be expanded beyond the traditional group of stockholders, customers, and employees. The author presents a model of decision analysis that includes a hierarchy of multiple objectives representing all stakeholders affected by the decision. [DA]

Kharbanda, O.P., and E.A. Stallworthy. *Waste Management.* New York: Auburn House, 1990.

This book presents a good introductory discussion on why industrial engineers should be concerned with pollution prevention. The increasing costs and hazards associated with waste handling require more comprehensive waste management. The authors describe the pollution hierarchy and call for wasteless processes wherever possible. Waste should be minimized only when wasteless processes do not exist. Where waste minimization is infeasible, recycling should be employed; waste treatment should be viewed as an alternative of last resort.

The book describes our society's waste problems, emphasizing management's role in implementing

solutions. Specific production control and management techniques are discussed along with clear examples of pertinent technologies that can be employed in facilities planning; these examples would be very appropriate for classroom discussion of pollution prevention techniques. [G][FP][OD/MC][PC]

Kirsh, F.W., and G.P. Looby, "Case Study: Pollution Prevention in Practice." *Pollution Prevention Review* 1, no. 2 (Spring 1991): 25–28.

This article presents four case studies that show how small- and medium-sized companies can not only reduce waste, but also save enough money to pay for any capital changes. [G]

Koelsch, James R. "Knee Deep in Liability?" *Manufacturing Engineering* 107 (August 1991): 28–33.

The article outlines the negative results of not handling spent coolants properly. It discusses how one production manager faces fines and imprisonment for not handling spent coolants as outlined in the Resource Conservation and Recovery Act (RCRA). It also covers management techniques (planning, documentation, and proper maintenance) that not only reduce liability, but reduce spent coolant as well. While pollution prevention is not explicitly discussed, it is the underlying message in the article. [G]

Koenigsberger, M.D. "Preventing Pollution at the Source." *Chemical Engineering Progress* 82 (May 1986): 7–9.

The article briefly outlines 3M's efforts in pollution prevention. It suggests methods for implementing a P2 program and discusses the following potential barriers:

- Senior management support may be difficult to get.
- Even though operating and maintenance costs almost always make pollution more expensive to control than prevent, the initial investment for pollution prevention equipment might still be higher.
- P2 technology may not be viable.
- P2 may be viewed as an untried substitute.
- Marketing often hinders reformulation. [G]

Konz, Steven A. *Facility Design*, pp. 347–353. New York: John Wiley and Sons, 1985.

This is a is a textbook for the field of facilities planning. The section cited briefly discusses the importance of including waste reduction criteria in the facility design process. Includes industry examples. [FP]

Kraft, Robert L. "Incorporate Environmental Reviews Into Facility Design." *Chemical Engineering Progress* 88 (August 1992): 46–52.

This article provides a comprehensive plan for incorporating environmental concerns into facility design. Although the issues addressed tend to be chemical process-oriented, the techniques outlined can be generalized to all manufacturing. The 10 components of the review process are:

1. Conduct initial and pre-design assessments.
2. Assign project environmental responsibility.
3. Define the project's environmental objectives.
4. Identify the need for any permits.
5. Determine environmental compliance requirements.
6. Perform an overall waste minimization analysis.
7. Apply "best environmental practices" for emission-free and discharge-free facilities.
8. Determine waste treatment & disposal requirements.
9. Perform engineering evaluations of waste management options.
10. Complete project environmental review. [FP]

Maruchek, Ann, and Lansdon Robbins. "Business Ethics: The Materials/Manufacturing Perspective." *Production and Inventory Management Journal* 29 (4th Quarter 1988): 16–19.

The authors contend that true impacts of "green" consumerism can be made in the supplier/customer relationship rather than in the consumer sphere. Increasingly, the supplier's product affects the customer's reputation and even liability. The authors show how environmental sensitivity is everyone's concern, and that activities such as purchasing can effect the environment. [PC]

Molinaro, Lawrence, Jr. *Production and Operations Management and the Environment.* Washington: Management Institute for Environment and Business, 1991.

This reader, the first of seven MEB modules on environmental considerations in business, includes articles and case studies relevant to several subdisciplines in IE/OR. Chapter 1, "Introduction to Pollution Prevention and Waste Reduction," applies to all. Chapters 6, "Managing Technology for Environmental Strategy," and 7, "The Regulatory Environment and Operations," apply to organizational design and management of change. Chapters 2, "Waste Minimization in the Production Process," 3, "Materials Management," and 4, "Quantitative Models: Environmental Management

Applications," apply to production control. Chapters 2 and 5, "The Environmental Audit," apply to Total Quality Management. [OD/MC][PC][TQM]

O'Sullivan, Dermot. "Bayer Targets Process Modification as Approach to Pollution Prevention." *Chemical & Engineering News* 69 (October 21, 1991): 21–25.

This article discusses how the large chemical company has targeted one sixth of its capital spending in pollution prevention. The article discusses incorporating the "prevention, reduction, recycling" idea into the corporate culture. Specific projects are also discussed. [OD/MC][G][PC]

Olsen, Marvin E. "Public Acceptance of Consumer Energy Conservation Strategies." *Journal of Economic Psychology* 4, no. 2 (October 1983): 183–196.

The policy of reducing consumer energy consumption can be implemented through several broad courses of action. This study investigates six alternative strategies for promoting energy conservation: financial incentives, community programs; efficiency standards, land-use changes, consumption limits. and price increases. Public acceptance of the strategies varies widely, from 83% for financial incentives to 9% for price increases. The single best predictor of acceptance is preference for a soft rather than hard energy policy path; the second-best predictor is perceived seriousness of the energy problem. In general, Americans can be described as supporting a diverse set of strategies for encouraging consumer energy conservation. [OD/MC]

Oskamp, Stuart. "Psychology's Role in the Conserving Society." *Population and Environment* 6, no. 4 (Winter 1983: Behavioral Science Issue): 255–293.

The author defines the hard energy path as: heavy reliance on high technology, highly centralized power plants, and recklessly high levels of energy use. This is perpetuated by extremely powerful institutional and societal forces. Industry has huge investments in present equipment and procedures. Many policy implications can be drawn from psychological research: Emphasize individual benefits of conservation rather than sacrifices. Don't make financial savings the sole justification for conservation. Don't expect information alone to motivate people to conserve. Stress benefits of conservation to society in order to give people an altruistic rational for conserving. Finally, whenever possible, spread conservation information through interpersonal interaction and "hands on" demonstrations rather than through the impersonal mass media. [OD/MC]

Painter, John, Rachel Semenik, and Russell Belk. "Is There a Generalized Energy Conservation Ethic? A Comparison of the Determinants of Gasoline and Home Heating Energy Conservation." *Journal of Economic Psychology* 3, no. 3-4 (September 1983): 317–331.

Compared to other socially responsible behaviors such as pollution reduction, the conservation of energy is more likely to be motivated by more purely economic incentives. The study suggests that studies of conservation behavior that combine conservers of different fuels or that attempt to generalize from conservation of one fuel to conservation of others may be quite misleading. [OD/MC]

Piasecki, Bruce, and Peter Asmus. *In Search of Environmental Excellence.* New York: Simon and Schuster, 1990.

Chapter 5, "Industry and the Environment: Creating Affordable Beliefs," discusses the need and provides examples of how companies have made the organizational and cultural changes required for successful pollution prevention. Many of these changes mirror those required for the successful implementation of quality programs. [OD/MC][TQM]

Pojasek, Robert B. "For Pollution Prevention: Be Descriptive Not Prescriptive." *Chemical Engineering* 98 (September 1991): 136–139.

The author describes a "descriptive" approach to pollution prevention. This type of strategy is required for studying unique processes. Under this plan, those people closest to the process are called upon to develop creative and innovative solutions to the pollution problems at hand. [G]

Pojasek, Robert B., and Lawrence J. Coli. "Measuring Pollution Prevention Progress." *Pollution Prevention Review* 1, no. 2 (Spring 1991): 119–130.

Successful pollution prevention programs require quantifiable measures, which are used in identifying waste streams and providing goals for future improvement. Issues in developing these measures are discussed. [G]

President's Commission on Environmental Quality, Quality Environmental Management Subcommittee. *Total Quality Management: A Framework for Pollution Prevention.* Washington: President's Commission on Environmental Quality, 1993.

Under the auspices of the President's Commission on Environmental Quality (PCEQ), 11 corporations volunteered to demonstrate the viability of TQM as a methodology for achieving pollution prevention. Included are summaries of the results of projects at AT&T, Chevron, Dow, DuPont, Ford, GE, International Paper, Merck, Procter & Gamble, 3M, and the U.S. Generating Company. [TQM]

Price, Roger L. "Stopping Waste at the Source." *Civil Engineering* 60 (April 1990): 67–69.

Inventory control, material-handling, and scheduling all provide opportunities for waste reduction. These traditional industrial engineering fields require an environmental "spin" before waste reduction opportunities can be identified. The author also discusses process redesign, raw material substitution, and industrial ecology. [PC][G]

Remmers, J., Th. Morgenstern, G. Schoens, H.-D. Haasis, and O. Rentz. "Integration of Air Pollution Control Technologies in Linear Energy-Environmental Models." *European Journal of Operational Research* 47 (1990): 306–316.

This article discusses alterations to the Energy Flow Optimization Model (EFOM) to address pollution reduction. The model was generated as a result of concern over Europe's increasing levels of air pollution. [OR]

Robinson, Alan G., and Dean M. Schroeder. "Detecting and Eliminating Invisible Waste." *Production and Inventory Management Journal* 33, no. 4 (Fourth Quarter 1992): 37–42.

This article discusses the idea of invisible waste in the production process. It explores why the waste is invisible, identifies sources of those wastes, and proposes the following principles to detect and eliminate them:

1. When evaluating or applying a new management technique, identify the sources of waste that it exposes or eliminates, those that it cannot expose or eliminate, those it will create, and the complementary techniques required to address these limitations.
2. Do not limit training to specific job methods — employees must also know how to make improvements to their jobs.
3. Increase the number of perspectives from which the process is seen.
4. Whenever significant change is made to any component of the productive system, examine the entire process for new sources of waste.

While the authors expand the definition of waste to include labor inefficiencies, the principles presented are relevant to pollution prevention. [PC][TQM]

Schmidheiny, Stephan, with the Business Council for Sustainable Development. *Changing Course: A Global Business Perspective on Development and the Environment.* Cambridge, MA: MIT Press, 1992.

Developed under the auspices of an international group of business leaders, this comprehensive book looks at all aspects of integrating environmental concerns into industrial management. The chapters are (1) "The Business of Sustainable Development"; (2) "Pricing the Environment: Markets, Costs, and Instruments"; (3) "Energy and the Marketplace"; (4) "Capital Markets: Financing Sustainable Development"; (5) "Trade and Sustainable Development"; (6) "Managing Corporate Change"; (7) "The Innovation Process"; (8) "Technology Cooperation; (9) "Sustainable Management of Renewable Resources"; and (10) "Leadership for Sustainable Development." The case studies about managing change in business, business partnerships, stakeholder partnerships, financial partnerships, cleaner production, cleaner products, and sustainable resource use are apropos to industrial engineering. Chapters 1, 6, 7, 8, 9, and 10 are especially relevant to organizational design and management of change, as are the case studies about managing business, business partnerships, stakeholder partnerships, financial partnerships, and sustainable resource use. Chapters 1, 3, 7, and 8 are especially relevant to production control, as are the case studies about managing cleaner production, cleaner products, and sustainable resource use; those cases are also relevant to facilities planning. [G][FP][OD/MC][PC]

Tusa, Wayne. "Developing an Environmental Audit Program." *Risk Management* 32 (August 1987): 24–29.

The article discusses reasons for and ways to set up an environmental audit program. Though not stated in the article, such a program ties in nicely with quality audit systems. [TQM]

U.S. Environmental Protection Agency, Office of Pollution Prevention. *Pollution Prevention 1991: Progress on Reducing Industrial Pollutants.* EPA/21P-3003. Washington: U.S. EPA, 1991.

This EPA publication presents trends and describes industrial and governmental programs. Chapter 3 provides examples of specific organizational efforts to better facilitate pollution prevention. It is good reference for governmental contacts. [OD/MC]

Upton, Dave, and Joshua Margolis. "Australian Paper Manufacturers," Cases A and B (Report #N9-691-041). Boston: Harvard Business School, 1990.

In the light of a competitor's problems with toxic chemicals, these cases explore Australian Paper Manufacturers' options in expanding uncoated, fine paper capacity, along with dealing with toxic chemicals, forestry and recycling. [PC]

Van Steen, Jacques F.J. "A Methodology for Aiding Hazardous Materials Transportation." *European Journal of Operational Research* 32 (1987): 231–244.

Risk assessment plays a large role in environmental decision-making. This article develops a model for risk analysis associated with the transportation of hazardous waste. Value judgments and the perception of risk are included in the model. [DA]

Van Weenen, J.C, and J. Eckels. "Design and Waste Prevention." *The Environmental Professional* 11 (1991): 231–235.

The article discusses methods for designing products and processes with waste prevention as a specific goal. A matrix method — the Design Environment Cube (similar to life-cycle matrices and "house of quality" models) — is presented. The authors then point out that further research is needed in the areas in decision-making systems, influencing systems, and design for durability and reuse. [FP][TQM]

Von Winterfeldt, Detlof. "Setting Standards for Offshore Oil Discharges: A Regulatory Decision Analysis." *Operations Research* 30 (September/October 1982): 867–886.

Offshore oil production platforms continually discharge oily water into the surrounding marine environment. To reduce the environmental risk from these discharges, emission standards are set on the oil concentration in the effluent. This paper describes a decision-analysis model for aiding regulators and platform operators in the standard-setting process. The model combines three submodules: a regulator model, an operator model, and an impact model. [DA]

Winett, Rachel A., and Peter Ester. "Behavior Science and Energy Conservation: Conceptualizations, Strategies, Outcomes, Energy Policy Applications." *Journal of Economic Psychology* 3, no. 3-4 (September 1983): 203–229.

The importance of human behaviors in energy conservation is well-known in behavior science, but this position has hardly made its way into policy. The authors suggest these preliminary steps as a minimum:

1. Delineate the most significant energy-consuming practices.
2. Assess technical contexts — make sure policy is pertinent to consumer behavior.
3. Assess attitudes, beliefs, information, values, and current behaviors concerning the practices in different population segments.
4. Conduct analyses by population segments — mismatches lead to failure.
5. Pre-test material to assure quality.
6. Analyze higher -level influences limiting change.
7. Use substitution strategies — decrease an inappropriate behavior and increase the appropriate one.
8. Use reciprocal reinforcement — reward multiple and concerned parties for their efforts. [OD/MC]

Wisner, Joel D., and Stanley E. Fawcett. "Linking Firm Strategy to Operating Decisions Through Performance Measurement." *Production and Inventory Management Journal* 32, no. 3 (Third Quarter 1991): 5–11.

Companies must reevaluate their approach to competition in the global economy. One area that needs reevaluation is performance measurement. In order to guide a firm's operating decisions toward strategic objectives, performance criteria must be flexible, easy to implement, timely, clearly defined at all management levels, and derived from the firm's strategic objectives. The article discusses the characteristics of world-class manufacturers and how they use performance measures competitively. It then discusses the development of a successful performance measurement system with criteria in quality, cost, flexibility, dependability, and innovation. Noticeably missing is the area of environmental performance. But, given (a) the authors' premise that these performance measures should be derived from a firm's strategic plan, and (b) the increasing strategic emphasis on environmental quality, environmental performance measures are a logical extension. The development of such criteria might serve as a good classroom exercise in a production control, operations management, or quality class. [PC][TQM]

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	G	CB	DA	FP	OR	OD/MC	PC	TQM
Alm, 1992								✘
Amoco, 1995			✘					
Ausubel and Sladovich, 1989						✘	✘	
Bender et al., 1981			✘		✘			
Berglund and Lawson, 1991	✘							
Bodily, 1982					✘			
Brown, 1981						✘	✘	
Burall, 1991				✘		✘		
Cairncross, 1991						✘	✘	✘
Caplan, 1992/93						✘		✘
Chechile and Carlisle, 1991			✘					
Cramer and Roes, 1993						✘		✘
Dauncey, 1991	✘							✘
Deland, 1991	✘							✘
Early, 1990				✘				
Feichtinger and Luptacik, 1987					✘			
Freeman et al., 1992	✘						✘	✘
Friedlander, 1989	✘							
Frosch and Gallopoulos, 1989	✘						✘	✘
Goldner, 1991	✘					✘		
Green, 1993								✘
Gregory et al., 1992					✘			
Hahn, 1984					✘			
Hämälainen, 1992			✘					
Harmon (Logical Role), 1995	✘							
Harmon (P2 and Fac. Plan.), 1995				✘				
Harmon (TQM), 1995								✘
Harmon (Tragedy), 1995			✘					
Harmon and Murty, 1995								✘
Haynsworth and Lyons, 1987							✘	
Hirschhorn and Oldenburg, 1991						✘	✘	✘
Imbler, 1989	✘	✘						
Keeney, 1988			✘					
Kharbanda and Stallworthy, 1990	✘			✘		✘	✘	
Kirsh and Looby, 1991	✘							
Koelsch, 1991	✘							
Koenigsberger, 1992	✘							
Konz, 1985				✘				

	G	CB	DA	FP	OR	OD/MC	PC	TQM
Kraft, 1992				x				
Maruchek and Robbins, 1988							x	
Molinaro, 1991						x	x	x
O'Sullivan, 1991	x					x	x	
Olsen, 1983						x		
Oskamp, 1983						x		
Painter et al., 1983						x		
Piasecki and Asmus, 1990						x		x
Pojasek, 1991	x							
Pojasek and Coli, 1991	x							
PCEQ, 1993								x
Price, 1990	x						x	
Remmers et al., 1990					x			
Robinson and Schroeder, 1992							x	x
Schmidheiny, 1992	x			x		x	x	
Tusa, 1987								x
Upton and Margolis, 1990							x	
U.S. EPA, 1991						x		
Van Steen, 1987			x					
Van Weenen and Eckels, 1991				x				x
Von Winterfeldt, 1982			x					
Winett and Ester, 1983						x		
Wisner and Fawcett, 1991							x	x

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