Snapshots of Environmental Cost Accounting

A Report to:
US EPA
Environmental Accounting Project

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SNAPSHOTS OF ENVIRONMENTAL COST ACCOUNTING

Prepared for:

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Office of Pollution Prevention & Toxics
Environmental Accounting Project

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DISCLAIMER

This report presents a number of Environmental Cost Accounting snapshots and case studies developed in recent years by a diverse group of organizations. The concepts, terms, and approaches represented throughout the report represent many different philosophies and means of applying Environmental Accounting (EA) principles and do not necessarily represent the position or views of the US Environmental Protection Agency (EPA). Through the production of this report, the EPA is presenting many different possible approaches to EA without intending to endorse any one. Readers may also want to consult *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms*, EPA 742-R-95-001 (June 1995) for more general information about environmental accounting.

This document and information on the US Environmental Accounting Project can be accessed via the Project's website at http://www.epa.gov/opptintr/acctg.

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TABLE OF CONTENTS

WHAT IS THE PURPOSE OF THIS REPORT?

This report demonstrates the financial results of actual environmental accounting applications. It highlights 39 cases of companies using various forms of environmental accounting (EA) and offers a more detailed review (snapshot) of all of these cases. The snapshots represent applications of EA in small, medium, and large businesses in a variety of industries, and in a range of business decisions. Examples run the gamut from a small manufacturer of wooden doors examining an investment in a new lacquer process, to a large, multinational health care products company measuring the value of its proactive environmental management program.

The intent of this report is to document how the application of EA principles can have a direct, positive, bottom-line effect on business operations. This collection of existing snapshots will form the basis of a larger, "living" database of EA snapshots to which individual companies can both refer and contribute. This database will be made accessible on the Internet at http://www.epa.gov/opptintr/acctg.

This report was funded by EPA's Environmental Accounting Project to respond to requests from stakeholders for more information on the application of environmental accounting concepts in various business decision making processes.

The Environmental Accounting Project began in 1992 in response to concerns that pollution prevention would not be adopted as the first choice of environmental management by industry until the environmental costs of non-prevention approaches and the economic benefits of pollution prevention become evident to managers. The mission of the Project is to encourage and motivate business managers to understand the full spectrum of environmental costs, and integrate these costs into decision making.

The collection of cases can serve engineers, accountants, financial analysts, operations managers, environmental managers, and general managers as a reference source on the range and business benefits of applying EA concepts.

Section 1 briefly introduces the reader to environmental accounting. Section 2 follows with an overview of the 39 cases, including a profile of the facilities studied, the EA methods they used and the results achieved. Section 3 presents snapshots of all cases, representing a diversity of companies, applications, and outcomes. Appendices containing a glossary and a form for reader feedback round out the report.

In addition to the EA snapshots in this report, the Environmental Accounting Project has developed case studies that examine how AT&T and Ontario Hydro (a Canadian public utility) have developed corporate-wide environmental accounting programs. To access these case studies or for more information on EPA's Environmental Accounting Project and additional resources, visit the Project's website at:

http://www.epa.gov/opptintr/acctg/

or contact EPA's Pollution Prevention Information Clearinghouse:

phone: 202/260-1023
fax: 202/260-4659
email: ppic_group@epamail.epa.gov

If you are interested in offering a snapshot of one of your firm's EA applications to the Environmental Accounting Project's Snapshot Database, please contact the Environmental Accounting Project by phone at 202/260-4164 or by fax at 202/260-0178.

1. Introduction

A business's long-term profitability depends on the quality of the product or service it offers, the demand for the product or service, and its ability to produce efficiently. Efficient production means maximizing output for a given level of input, or conversely, minimizing input for a given level of output. Firms that consistently produce efficiently create a sound competitive advantage for their enterprises.

A critical element of efficient production is the accurate and consistent measurement of inputs and outputs. The often repeated axiom "what gets measured gets managed" has never been more true. Without accurate cost information, it is difficult to adequately assess the profitability of a product, a department, or a firm, and even more difficult to know what changes to make in order to improve profitability in today's highly competitive business climate. Management accounting systems can provide the information required to make those decisions.

Why Measure Environmental Costs?

Environmental costs are impacts incurred by society, an organization, or an individual resulting from activities that affect environmental quality; these impacts can be expressed in monetary or non-monetary terms. They include any such cost, direct or less tangible, with short- or long-term financial consequences for the firm. These costs are often not tracked by or are hidden in overhead accounts within traditional management accounting systems, but they can be a significant component of a firm's overall cost structure. The failure to include them in financial analyses has the effect of sending the wrong financial signals to managers making process improvement, product mix, pricing, capital budgeting, and other routine decisions. In an increasingly global economy, where labor, materials, and capital costs are likely to converge over time, effective management of environmental costs and performance may become increasingly important in determining corporate winners and corporate laggards.

Mounting pressures on industry to achieve strong environmental performance have a number of ramifications for the business community. First, some costs of doing business that have traditionally been external to the firm – e.g., health effects of air pollutants – are being shifted to the firm's balance sheet and income statement through regulation. This shift is the result of more stringent rules regarding pollutants already regulated and new rules affecting previously unregulated pollutants.

Second, just as the outcry over questionable and secretive management of corporate finance led to financial disclosure regulations early this century, today's stakeholders are demanding public disclosure of environmental performance information. The result of this trend is that activities with direct or indirect adverse environmental effects are becoming more costly to operations, to capital budgets, and to stock prices[1].

Even absent external pressure, the true costs of environmental impact – including the costs of waste, of liability, of diminished image – though often obscured by biases associated with traditional systems are real and can be significant. Actively managing these costs is therefore an important aspect of maintaining a lean, profitable business. Whether driven by internal motivation

[1] Feldman, Stanley J., Peter A. Soyka, & Paul Ameer. *Does Improving A Firm's Environmental Management System and Environmental Performance Result in a Higher Stock Price?* ICF Kaiser Working Paper, 1996.

or external concerns, a firm can create a sustained competitive advantage by systematically reducing environmental costs. And the first and critical step of cost reduction is improved cost identification and management.

What is Environmental Accounting?

Environmental Accounting (EA) is a broad-based term that refers to the incorporation of environmental costs and information into a variety of accounting practices. Figure 1 below depicts some of the different contexts in which EA is used. At a macroeconomic level, EA is used to account for costs associated with a region's stocks and flows of natural resources. A redefinition of national income that incorporates such environmental accounts into conventional measures such as the Gross Domestic Product is an example of macroeconomic EA.

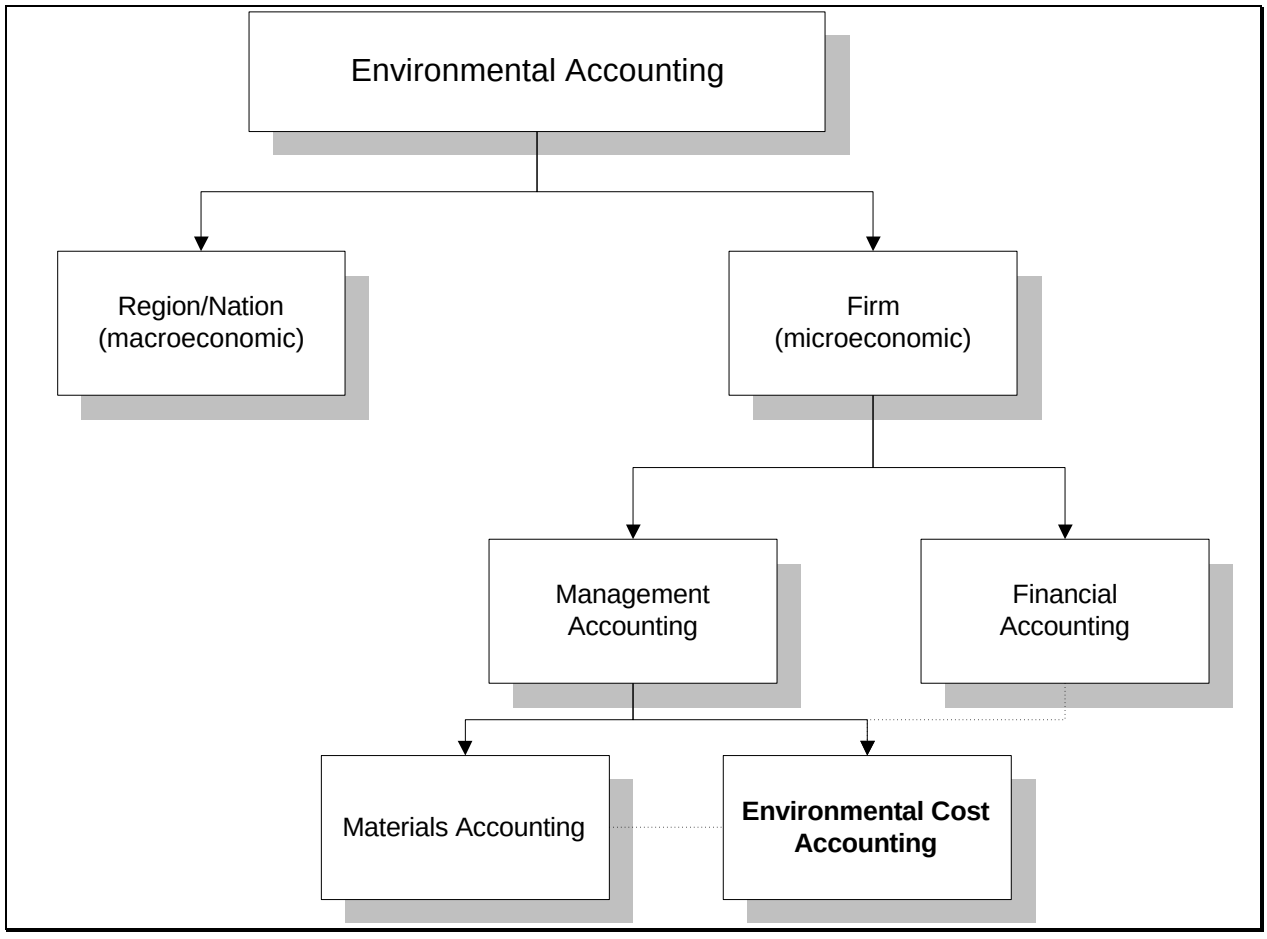

Figure 1. Some Contexts of Environmental Accounting

At the microeconomic or firm level, EA can apply to both financial accounting and management accounting. Financial accounting, whereby a firm reports its economic activity to an external audience, has requirements for disclosure of environmental liabilities and certain environmental costs. This application of EA is governed by the "Generally Accepted Accounting Principles" which are established by the Federal Accounting Standards Board and the US Securities and Exchange Commission.

In terms of management (or internal) accounting, EA is the way that businesses can account for the material use and environmental costs of their operations. Materials accounting is a means of

tracking material flows through a facility in order to characterize inputs and outputs for purposes of evaluating both resource efficiency and environmental improvement opportunities.

Environmental cost accounting (ECA) is how environmental costs – including those that are often hidden in general overhead accounts – are identified and allocated to the material flows or other physical aspects of a firm's operations (as might be identified via materials accounting). The application of these internal EA concepts provides consistency between an organization's environmental goals and its financial goals, meaning environmental improvement can directly lead to financial improvement. It is this direct link between the financial and the environmental performance that makes robust environmental accounting practices so compelling.

Financial accounting and its environmental requirements have been standardized to provide consistent and comparable information to investors, regulators and other stakeholders, while management accounting practices vary widely from firm to firm. Likewise, the manner in which firms apply EA principles differs. A few firms make efforts to identify their relevant environmental costs and to use this additional information to guide business decisions. Most firms, however, operate without recognizing the magnitude or source of these costs, which can lead them to poorly informed decisions. Correcting this information gap is the primary purpose of EA.

How Can EA Support Business Decision Making?

The concepts of EA as they apply to internal management decisions are the focus of this document. In this context, EA concepts can be applied at all levels of an organization to help make sound business decisions such as those in Table 1 below. Accurate, timely information is the critical underpinning of business decision making, and EA practices provide means of exposing information obscured by conventional management accounting practices.

Table 1. Business Decisions Supported by EA[2]

Product Design	Capital Investments
Process Design	Cost Control
Facility Siting	Waste Management
Purchasing	Cost Allocation
Product/Process Costing	Product Retention/Mix
Risk/Liability Management	Product Pricing
Strategic Planning	Performance Evaluations
Supplier Selection	Plant Expansion
Environmental Program Justification	

The cases included in this document relate to only a few of these business decisions. While applications relating to capital investments, product/process costing, and strategic planning have been better documented than the rest, a broad range of business decisions can benefit from the adoption of EA principles. As the preceding table and graphic indicate, environmental accounting

[2] Adapted from US EPA's *An Introduction to Environmental Accounting As A Business Management Tool: Key Concepts and Terms* (EPA 742-R-95-001), page 6.

can play a role in many aspects of business management. To the extent that environmental costs exist in almost every phase of a business' operations, EA practices can support improved decision making in many different applications throughout an organization. Following are descriptions of some of the more common applications to date.

EA Informs Product/Process Costing

Businesses generally look to the marketplace to gauge the demand for a product and, from that demand, the price the market is willing to pay. They then compare that price to their cost of making the product to determine whether or not there is adequate profitability to justify its production. Of course, producers consider other factors – such as market positioning, customer retention, and long-term sector growth – when deciding what and how much to produce, but the costing of the product and the processes that produce it remains fundamental.

When environmental costs are not adequately allocated, cross-subsidization occurs between products. In most cases, different products are made by different processes, and each process tends to have a different environmental cost. For example, consider a facility with two processes, A and B, that use the same number of direct labor hours for a batch of product. Process A, however, uses hazardous chemicals whereas process B does not. The facility incurs environmental costs from the use of the hazardous chemicals in a number of ways: specification and procurement of the chemical which includes evaluation of Material Safety Data Sheets; design of the process to minimize worker exposure; shipping costs associated with transporting hazardous chemicals; monitoring, reporting, and permitting to meet applicable regulations; employee training in handling and emergency response; storage and disposal costs; and liability for the chemical from purchase to grave. In addition, there may be less tangible costs such as tarnished corporate image and inability to meet delivery or quality requirements.

If all of these costs are bundled as 'environmental' overhead and allocated to processes A and B on the basis of direct labor hours or production volume (both common practices), products made by process B are in effect subsidizing those made by process A. In other words, a traditional accounting system would show process B to be more costly than it really is and process A to be less costly. Armed only with this information, managers are inclined to overestimate the profitability of products made by process A and correspondingly underestimate the profitability of those made by process B. Eventually, this type of accounting can put the firm at a considerable competitive disadvantage. Conversely, by more accurately allocating these costs, managers can make better decisions about product mix and about where cost-saving opportunities lie, thereby putting their firms ahead of the competition.

EA Informs Capital Investment Decisions

Companies develop and enlarge their businesses by investing in their human and physical capital. Their long-term financial viability hinges on the strength of these investments. Generally, a company's investors demand at minimum a return comparable to that which they can obtain through other investments. This demand places pressure on companies to invest their limited capital funds wisely. Environmental costs are often a significant component of capital and operating costs. There is often, therefore, a considerable financial return available to companies that can reduce these costs. When environmental costs are properly accounted for, investment analyses of environmental performance improvements provide managers with information to

determine whether and to what extent the benefits of such investments will exceed the costs. But to achieve these results, managers must first be able to define and measure these environmental costs in a systematic and consistent fashion.

One specific application of EA for capital investment analysis is Total Cost Assessment (TCA); a method by which investments, particularly environmental investments, can be evaluated in a way that more accurately reflects their profitability potential. The four basic elements of TCA that make it more informative than conventional analysis are: (1) a more comprehensive cost inventory that includes less direct, less tangible costs[3]; (2) allocation of costs that are typically assigned to overhead accounts, and either allocated on the basis of an inappropriate cost driver or not allocated at all; (3) evaluation of projects using longer time horizons in order to better capture the full benefit of the investment, a significant portion of which may be realized after the first 2-3 years; and (4) profitability indicators that account for the time value of money, making the results more realistic and reflective of an investment's true cost or benefit.

Evaluating environmental projects using TCA helps put them on equal footing with other projects competing for capital funds. Projects that appear to be financially weak using conventional analyses may look considerably stronger and more competitive once their true return has been identified. For example, an expensive investment in a process change to accommodate a switch to an aqueous solvent may appear to be a poor investment with a long payback if only direct labor and material costs are considered over a three-year time period. However, if the full environmental costs of the existing process – such as solvent disposal costs, regulatory permits, worker health, and liability for accidental spills or leaks – are allocated to the process and included in the analysis, the less visible cost savings associated with the switch, considered over a longer, 7-8 year period, may well yield an impressive rate of return and a shorter-than-expected discounted payback. Of course, TCA does not ensure profitability *a priori*. It does however ensure greater transparency, clarity, and rigor in making capital investment decisions.

EA Informs Strategic Planning

Understanding the nature and magnitude of its costs is vital to the successful, long-term operation of any firm. When planning strategically, businesses look externally at the markets they serve, and internally at the resources they control. They then are in a position to decide where the best profit potential lies and what strategies will be necessary to achieve that potential. Profit potential can be substantially affected by environmental costs and how they are managed. In this way, EA is a critical strategic element of long-term commercial success.

Looking outward, many businesses see customers that are increasingly more demanding in terms of quality, of which environmental performance is an integral component. Many companies that produce consumer products are finding lucrative markets in green goods where customers, who will often pay a premium for a green product, believe they can positively impact environmental quality through their purchasing decisions. Similarly, companies producing raw materials and intermediate goods are finding more stringent customer expectations with regard to environmental performance of both their operations and their products. To many consumers and buyers, good environmental management is indicative of a firm's general management and of its ability to consistently produce reliable, high-quality products. To the extent that the application of EA

[3] See Appendix A of this document for a glossary of terms. Also wee US EPA's *An Introduction to Environmental Accounting As A Business Management Tool: Key Concepts and Terms* pages 7-11 for a discussion of environmental costs.

concepts encourages financially sound investment in the production of products of higher environmental integrity, it can strategically position a business to seize this powerful market opportunity.

Customers and other stakeholders, to varying degrees, are calling for increased environmental responsibility on the part of businesses. Concepts of environmental accounting can be applied to the development of environmental management systems, including those consistent with the increasingly prevalent ISO 14000 standards, that enable strategies to answer that call. As firms position themselves to enhance the structure of their systems, EA will be integral to their development and capabilities. These systems coordinate EA-based data to provide managers with information to better understand the impacts of their decisions. This information can be used strategically to drive improved environmental performance.

A strategic vision and corresponding management commitment is necessary to fully integrate environmental costs into a company's business decisions. Viewed over the long term, those firms that properly account for the true environmental costs of their operations will be in a superior position to meet tomorrow's competitive challenges.

For a more complete description of EA concepts, readers are encouraged to see EPA's *An Introduction to Environmental Accounting As A Business Management Tool: Key Concepts and Terms* (EPA 742-R-95-001), available on the Internet at http://www.epa.gov/opptintr/acctg/

2. Overview of Cases

Case Selection

We selected cases from a broad survey of environmental cost accounting literature that documents actual applications of EA. The selection represents the result of library and Internet searches and discussions with EA practitioners. It contains a variety of applications of EA in a number of different industries and, we believe, presents a fairly comprehensive compilation of published EA cases as of the start of 1997. In addition, three cases were submitted by companies with an ongoing interest in the Environmental Accounting Project.[4] This collection is intended to be the beginning of a living database of environmental accounting snapshots that demonstrate results from applying EA to specific business decisions.[5]

We selected those cases that quantifiably demonstrate uses of EA in business decision-making. These studies show how businesses more carefully account for costs that are typically left out of conventional accounting practices and analyses. These costs, typically direct or indirect environmental costs obscured in overhead accounts, were in most cases significant and material to business decisions.

The cases reviewed in this report also tend to use profitability indicators that consider longer-term implications for operating costs, and consider the time-value of money when assessing and comparing profit and payback. Accounting practices that look beyond the next quarterly report better reflect the true cost of the processes they measure. Environmental costs and benefits often materialize over a time frame longer than that considered in conventional analyses. Applying EA concepts in business decisions, as shown in these case studies, can improve upon conventional systems by capturing these costs and savings to better inform management decisions.

Generally, we included case studies that used environmental accounting to provide better information about a product, a process, an investment, or a business operation. The cases represent a variety of approaches to the application of EA, but all have in common the incorporation of environmental costs into accounting practices, providing firms with both economic and environmental incentives to reduce waste and produce more efficiently.

Organization of the Cases

Business Decisions Examined

The cases are organized into three groups, based on the business decisions analyzed using environmental accounting concepts:

1. *Capital Investments* (24 cases). Many improvements to increase resource efficiency and reduce material use and pollution require capital expenditures. Methods of investment analysis, such as total cost assessment (TCA) – a comprehensive approach to evaluate the profitability of current business practices and pollution prevention (P2) investments – are

[4] One case by Chrysler Corporation and two by Bristol-Myers Squibb.

[5] If you are interested in offering a snapshot of one of your firm's EA applications to the Environmental Accounting Project's Snapshot Database, please contact the Environmental Accounting Project by phone at 202/260-4164 or by fax at 202/260-0178.

particularly useful in capital budgeting decisions when a firm seeks to assess the profitability of a potential investment or to choose between several potential investments.

2. *Product/Process Costing* (9 cases). Better information regarding operating costs is useful to a variety of pricing, product mix, investment, and strategic decisions. Understanding the true costs and risks of operations enables managers, engineers, and operators to make better decisions about how to run and improve their businesses.
3. *Strategic Planning* (6 cases). Quantifying the relative environmental costs of different processes and P2 opportunities provides the information necessary for prioritizing P2 projects, allocating resources, and determining a firm's environmental strategic direction. For example, with scarce capital funds firms find the application of EA concepts to be a valuable means of directing investment towards those opportunities that will provide the greatest return. Measuring the environmental costs and benefits of various activities throughout a facility or business gives managers information they need to plan strategically.

These three categories clearly overlap, and there are several case studies that could fit comfortably into more than one. The purpose of classification is not to draw artificial distinctions between types of EA applications, but to organize and illustrate the variety of business decisions EA can support. In the end, EA concepts can be employed to manage information that can be used in as many ways as businesses can creatively devise. A critical element of being a successful manager is to know what needs to be known and to utilize information about business operations to continuously improve them. The three categories cover the major ways in which environmental cost information has been used in the case studies.

Industry Sectors Examined

Within each section, the cases are grouped first by industry sector and then alphabetically. The total of 39 cases breaks down in the following manner:

Table 2. BREAKDOWN OF CASES BY INDUSTRY SECTOR

NUMBER OF CASES	INDUSTRY SECTOR
9	Chemicals
10	Metal finishing/fabrication/use
4	Printing
3	Electronics
3	Paper
2	Electrical utilities
8	Other*

*includes, for example, pharmaceuticals, health care products & auto manufacture

Size of Companies Examined

The companies in these case studies range in size from small, privately-held facilities with fewer than 20 employees to large, multinational corporations, such as Polaroid, Baxter, and DuPont. Table 2 suggests the firms also represent a broad range of the commercial sector, supplying both products and services to intermediate and end-use customers. This diversity demonstrates that both large and small businesses can often benefit from increasing incorporation of environmental

costs into business decisions. Potential EA applications lie along a spectrum of complexity and can be tailored to the needs of each business. However, there are costs to applying EA concepts, even on an ad-hoc basis, and these costs have to be measured against expected benefits. Some of the cases, however, show the investment in systems that incorporate EA concepts to be a worthwhile investment with initial costs that may be amortized over many years of improved decisions and decision-making.

Profile of the Cases

Why Was the Case Study Performed?

What motivated firms in the case studies to experiment with, or adopt EA methods? The firms listed here did so for a variety of reasons and in a variety of settings. Some were reporting on broader company or government policy issues of which EA was an integral component.

Some of the cases report on EA applications implemented by teams assembled within a firm, usually as part of a proactive management effort to improve cost accounting practices. The underlying aim of many of these efforts was to improve management decision making capabilities by providing a stronger foundation upon which smart decisions could be made. In these cases, identification and understanding of environmental operating costs led to strategies for making efficiency and environmental improvements. However, much of the reported EA work was performed by, or in collaboration with, external research and consulting organizations, owing to most firms' lack of experience in incorporating many of their environmental costs into their business decisions. In some cases, an external organization approached a firm about collaborating on a case study in conjunction with an EPA- or state-funded initiative.

In the cases where environmental costs were better integrated into business decisions with external support, the case study usually reports on a financial analysis of an environmental investment, often performed retrospectively (i.e., after the investment had already been made). A retrospective analysis allows the use of real operating cost data instead of estimates from the new investment in the financial analysis. These analyses help the firm to understand the full economic impacts of its investment to inform future decisions, highlight the difference between TCA and conventional accounting methods, and provide a model for other firms desiring to perform their own analyses. Roughly 20% of the cases in this report document analyses that were performed retrospectively.

Costs Considered

To what extent do the case studies embrace a wider range of costs beyond the conventional (those typically recognized in cost analyses, such as raw materials and capital equipment)? We earlier noted that an important element of EA is the consideration of a broader spectrum of costs. However, the majority of the case studies include only conventional and non-conventional/hidden costs[6] in their quantitative analyses; a few include only conventional costs. This suggests the difficult nature of identifying, isolating, allocating, and incorporating less tangible costs (those relating to stakeholder relationships or other costs that may be significant but similarly difficult to quantify) into a business decision. In many cases these less tangibles were deemed unnecessary for the analysis. Indeed, many of the capital investments analyses showed a proposed investment

[6] See the Glossary of Terms in Appendix A for a complete definition of these cost categories.

to be sufficiently profitable even in the absence of less tangibles. In other instances, firms that were unable to quantify liability/contingent and/or less-tangible costs did consider them qualitatively. Like other management concepts, the application of EA concepts supports decision-making but does not prescribe it. Ultimately, decisions are made considering not only readily measurable cost, but also "softer" factors such as corporate image, employee safety, or contingent environmental liability. In several of the capital budgeting studies, qualitative considerations played an important role in persuading the company management to make a P2 investment.

A number of cases quantify liability/contingent costs. For example, one firm considered the potential liability of a PCB transformer spill or fire.[7] Conservatively considering the probabilities and associated costs of cleanup, litigation, and lost production, the analysis showed an accelerated phase-out of the transformers to be cost-effective. This example shows how the inclusion of costs omitted from conventional analyses might lead managers to sharper, more proactive management strategies.

A few case studies identify other less-tangible costs and quantify them as part of an analysis. One study of the impacts of a forestry company on the commercial value of the forest estimated values of wildlife and tourism costs.[8] Two small printing companies estimated an increase in product revenues from improved ability to meet customer demand.[9] In these cases, cost estimates admittedly are rough, but even a rough, conservative estimation reflects the true economics of a current or proposed practice better than an estimation of zero, the value implied by the exclusion of a less tangible cost.[10]

Financial Results

What is the range of outcomes reported in the three categories of EA? The *Capital Investments* cases evaluate the profitability of past or proposed investments, or compare the economics of several P2 investment proposals. Almost all of the *Capital Investments* analyses calculated a net present value[11] (NPV) for the project; these values ranged from negative $1.4 million to $11 million, with most in the range of $10,000 to $100,000. Some of the highest include: a 5-year NPV of $495,860 for a screen printer; an 8-year NPV of $352,814 for an electronic equipment manufacturer; and a 15-year NPV of $11,633,835 for a diversified chemical company. Two of the 24 *Capital Investments* cases had negative NPVs, but both of these projects contained significant qualitative benefits. One of the projects was approved on the basis of these qualitative benefits. Many of the

CAPITAL INVESTMENTS CASE HIGHLIGHTS

- lowest investment NPV = negative $1,400,000
- highest investment NPV = $11,600,000
- typical investment NPV = $10,000 to $100,000
- small firm (screen printer): dry film imaging system investment, NPV = $496,000
- medium-sized firm (electronics): ultrasonic cleaning system investment, NPV = $352,000
- large firm (chemical company): byproduct recovery system investment, NPV = $11,600,000

[7] See the *Large Firm in Auto Industry* Snapshot on Page 88.

[8] See the *A Forestry Company* Snapshot on Page 78.

[9] See the *A Screen Printer* and *A Small Lithographic Printer* Snapshots on pages 41 and 43.

[10] See the US EPA's *Valuing Potential Environmental Liabilities for Managerial Decision-Making: A Review of Available Techniques* (EPA 742-R-96-003) for references to means of estimating liabilities.

[11] See the Glossary in Appendix A for a definition of this and other EA terms.

analyses for which a discounted payback was calculated would pay for themselves in under three years; all but two had paybacks under five years. In a few cases, however, the encouraging financial analysis was insufficient to override doubts about unproved technology, so project implementation was put on hold.

Product/Process Costing, the second category of EA cases, covers both facility-level and product/process level analyses. Most of these studies were undertaken as collaborative efforts; a number are part of a World Resources Institute study, one was funded by the UN to improve accounting and reporting, and another was supported by the Illinois Waste Management and Research Center to demonstrate improved process costing. Three studies in this category were initiated through corporate programs to improve environmental cost accounting. The *Product/Process Costing* cases all helped identify significant environmental costs that previously had not been recognized. The results convinced some of the firms to pursue P2 projects or to continue to refine their EA practices. Others assisted firms to consider potential benefits of enhanced corporate image, of improved customer satisfaction and employee morale, and of the competitive advantage from selling environmentally-friendly products.

Finally, the *Strategic Planning* cases also cover both facility-level and product/process-level analyses. Several were performed as a result of the New Jersey Planning Process[12], which requires an assessment of the costs of using or generating hazardous substances for each process in order to identify P2 opportunities. Others were motivated by corporate commitment to P2 and/or initiation of an accounting system that better incorporated environmental costs. Most of the *Strategic Planning* cases showed that P2 investments could actually save money and that EA helped the facility prioritize P2 options. These applications of EA tended to set the stage for a systematized integration of improved cost accounting into ongoing business initiatives to implement efficiency improvements.

[12] These include Witco Corporation, Sandoz Pharmaceuticals, and Unifoil Corporation.

3. Environmental Accounting Snapshots

Selection Rationale

To give readers more insight into the actual application of EA, 39 Snapshot summaries of the case studies reviewed are presented in this section. These Snapshots cover a spectrum of applications, and demonstrate the versatility of EA as well as the bottom-line outcomes of a range of applications.

Each snapshot contains the following information:

- Business Decision
- Business Benefits
- Company Profile
- Why Was Project Performed?
- Project Description
- Analysis
- Financial Parameters
- Financial Results
- Contact
- Source(s)

In seven cases, a further section on Institutional Change is included.

A DIVERSIFIED CHEMICAL COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Study of a set of process changes that would, among other things, convert byproduct into useable input material, potentially decreasing landfill waste by 3.8 million pounds per year.

BUSINESS BENEFITS

For a capital investment required of $4.96 million, annual operating costs are expected to decrease by $2.29 million.

COMPANY PROFILE

⇒ *Location*: About 450 facilities in 40 countries.

⇒ *Size*: Not reported

⇒ *Annual Revenues*: $12 billion

⇒ *Business*: Manufacturer of chemicals for sale to industry.

WHY WAS PROJECT PERFORMED?

This $12 billion company has about 450 facilities around the US and throughout the world. This particular project focuses on the activities at a group of three plants located in relatively close physical proximity. Plant 1 manufactures an intermediate product ***I***, which is delivered to Plant 2 and Plant 3, each of which converts ***I*** into final product ***F***. Not all of ***I*** is converted to ***F***, however. A portion remains as ***I***, and a portion is unavoidably converted to a byproduct, ***B***. ***B*** and ***I*** are combined and returned to Plant 1 for reprocessing. Plant 1 recovers most of ***I***, while ***B*** and the unrecovered ***I*** are landfilled.

PROJECT DESCRIPTION

In the mid-1970s, an alternative process was developed whereby ***B*** could be converted back into ***I***. This recovery facility would be located at Plant 2, and would process the effluent streams from Plant 3 as well as that from Plant 2. The recovered ***I*** would be sent to Plant 1 for purification. The recovery facility at Plant 2 would produce a waste stream that would need to be landfilled. The waste disposed annually by Plant 1 would decrease by 4.3 million pounds, while that disposed by Plant 2 would increase by 0.5 million pounds, resulting in an overall waste decrease of 3.8 million pounds per year.

Initially, the company's consideration of the process change centered on recovery of wastewaters containing ***B*** and ***I***. However, during the mid-1980s, the company became interested in converting ***B*** to ***I*** as a vehicle to increase production of ***I***, in order to expand production of ***F*** by Plant 2. A detailed study done at that time indicated a 29 percent return on investment for the project. Although the group of plants as a whole would see a decrease of 3.8 million pounds per year, no action was taken. This was in part because Plant 2, where the investment would be made, would see increased operating costs due to operations at the recovery facility plus the addition of 0.5 million pounds to its annual waste stream. Because of this, Plant 2 opposed the implementation of the project.

ANALYSIS

In addition to the recovery of ***I*** and reduced waste generation, this project offers several other benefits. First, since ***I*** and waste are removed from the wastewater at Plant 2, only ***I*** is shipped to Plant 1, reducing shipment costs. Second, the flow to the ***I*** purification system at Plant 1 is reduced, freeing up processing capacity in the system, and obviating the need for a major capital expansion project in the event of the need to increase production. This preserves and enhances the ability of the plants to respond to markets. Third, elimination of unreacted ***I*** from Plant 1 results in improved system operations and reduced costs. Finally, preliminary studies indicate that the ***I*** recovered from ***B*** at Plant 2 may be of sufficient purity to recycle directly into Plant 2, further lowering costs by reducing shipment and purification costs.

A DIVERSIFIED CHEMICAL COMPANY

COST CONSIDERATIONS

	Year One Savings
Recovered ***I***	$2,470,000
Waste Management	$44,100
Total Savings	**$2,514,100**
	Year One Costs
Additional Labor	$220,500
Total Costs	**$220,500**

The capital investment required is $4.96 million. Annual operating costs are expected to decrease by $2.29 million. This decrease is due primarily to the value of the recovered ***I***, $2.47 million annually. This value is modified by a $220,500 increase in labor costs and a $44,100 decrease in waste management costs.

The total cost analysis (TCA) makes no modifications to the company analysis discussed above. However, an additional category of cost is considered: estimated potential liability cost. This cost represents the financial liability which may be avoided by reducing the ***B*** waste stream. At present, this waste is disposed in a privately owned industrial landfill. Although the company has no reason to believe the landfill is now or may in the future be subject to remedial action, this project may reduce a degree of incremental financial risk which a conservative project analysis out to account for. This risk is represented by a one-time $4.6 million cost in year ten of the investment.

FINANCIAL PARAMETERS The financial analysis uses a discount rate of 12 percent, an inflation rate of 5 percent, a net tax rate of 34 percent, and double declining balance/straight line depreciation over a fifteen year period.

FINANCIAL RESULTS For the TCA, the 15 year NPV is $11,633,835; the 15 year IRR is 41%; payback is 2.2 years. The company's analysis, without the estimated potential liability cost, produces slightly different results: the 15 year NPV is $10,035,274; the 15 year IRR is 40%; and the payback period remains at 2.2 years.

CONTACT Deborah Savage, Tellus Institute, 617-266-5400

SOURCES White, Allen L., Monica Becker, and James Goldstein, *Alternative* Approaches *to the Financial Evaluation of Industrial Pollution Prevention Investments*. Prepared for NJ DEP. November 1991. **And** White, Allen L., Deborah Savage, and Monica Becker, *Revised Executive Summary*. June 1993.

POLAROID CORPORATION

BUSINESS DECISION

CAPITAL INVESTMENTS

A closed-loop batch still solvent recovery system had been left only partially completed for several years due to cash flow problems. Should the project be permanently canceled or should additional investments be made to complete the project?

COMPANY PROFILE

⇒ *Location*: Waltham, MA

⇒ *Size*: 11,000 employees

⇒ *Annual Revenues*: $2.4 billion

⇒ *Business*: Specialty chemical manufacturing

BUSINESS BENEFITS

The benefits of completing the still are heavily dependent on a number of decisions related to chemical production. Five different scenarios were created and analyzed to represent these decisions, yielding 12-year net present values ranging from –$1.4 million to +$3.4 million.

WHY WAS PROJECT PERFORMED?

Polaroid had designed a state-of-the-art, closed-loop, multipurpose batch still solvent recovery system for one of its facilities. At the time of the study, construction on the project had stopped for several years due to cash flow problems. The company had invested approximately six million dollars in the state-of-the-art system; an additional four million dollars was needed to complete the system as designed, primarily for equipment and control components.

During the construction delays changes to facility operations took place which, together with the significant construction downtime, rendered invalid the firm's initial profitability analysis. Tellus Institute was asked to revisit the original project analysis with a particular focus on identifying and—if warranted and feasible—quantifying less tangible cost items.

PROJECT DESCRIPTION

When it was designed, the solvent recovery still was intended to provide two classes of savings: (1) reduced waste disposal fee costs, and (2) reduced raw materials purchases. During the construction delay, which lasted several years due to ongoing competition for capital funds, facility production plans changed, clouding the question of how many waste streams on site would be suitable for batch still recovery.

Adding to the complexity of the analysis were multi-facility production planning issues, company and government hazardous waste reduction goals and air emission regulatory issues. For example, the production facility at which the batch still had been partially constructed had no other solvent recovery capacity on site. A second production site in the same region had several operating recovery systems, but all were operating at full capacity. This limitation on available solvent recovery capacity had clear production implications for production lines that used expensive raw materials or that generated solvent wastes deemed too expensive to simply ship off site for disposal. In addition, government regulations restricted shipment of wastes between the two sites for solvent recovery, further constraining the company's flexibility for planning production.

Having a batch still system on site would also affect the company's ability to meet both internal, company-wide hazardous waste reduction goals, as well as similar state-mandated goals. The batch still was viewed internally as an important component of future hazardous waste treatment and air emissions flexibility.

POLAROID CORPORATION

SOURCES ANALYSIS Initially it was thought that easily quantifiable waste management costs, such as permit costs, labor costs for shipment manifesting, etc., would play a significant role in the analysis. It soon became clear that these costs, although relevant, were not decision drivers in an investment of this size.

It became clear that the primary cost drivers were of two types:

(1) The handler for one of the facility's waste streams (designated Stream A) had had safety problems in the past, and the facility's environmental manager would like an alternative treatment option. In absence of the batch still, the only alternative was cement kiln treatment, estimated to have a cost eight times that of the current handler.

(2) The ability of the facility to expand production to include a major intermediate product (Product X) that the firm was currently buying from another manufacturer. Without the batch still recovery system, the costs associated with waste disposal and raw material would make in-house production too expensive.

In addition, the completion of the batch still could be carried out at lower cost by modifying both its design and construction techniques. Five different scenarios were developed: 1) using the kiln to recover waste streams generated on-site, assuming they would otherwise be handled as they currently are; 2) as (1), but assuming Stream A's would otherwise face cement kiln disposal; 3) as (1), but implementing the lower cost completion method; 4) handling waste from production of Product X with the still, thus enabling the savings this on-site production would yield, and; 5) as (4), but implementing the lower cost completion method.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS 12-year NPVs ranged from –$1.4 million [for (1)] to +$3.4 million [for (5)] for scenarios representing different waste stream mixes, capital expenditure, etc. The TCA helped illuminate the critical link between the batch still project and broader questions of production planning capacity and flexibility. In order to preserve these competitive capabilities, upper management approved funding for completion of the batch still project. The experience has informed continuing refinement of company's cost accounting system.

INSTITUTIONAL CHANGE Prior to the analysis of the batch still, Polaroid had looked at compliance without taking into consideration any possible benefits other than compliance itself. This project showed Polaroid that concurrent evaluation of compliance and engineering can enhance facility performance. The comprehensive analysis used in this project serves as a model for how Polaroid now analyzes all projects.

CONTACT Deborah E. Savage or Allen L. White, Tellus Institute, 617-266-5400.

White, A.L., D.E. Savage, and A. Dierks, "Environmental Accounting: Principles for the Sustainable Enterprise." Originally presented at the 1995 TAPPI International Environmental Conference, Atlanta Georgia, May 7-10 1995.

White, Allen L. and Deborah E. Savage, "New Applications of Total Cost Assessment: An Exploration of the P2-Production Interface." *Pollution Prevention Review.* Winter 1994-1995.

ALUMINUM PROCESSING COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

What is the return on an investment in replacing a vapor degreasing system with an aqueous degreasing system?

BUSINESS BENEFITS

For an initial investment of $155,365, the company realizes savings in the first year of $54,474. The 10 year net present value (NPV) of the investment is $101,292.

COMPANY PROFILE

⇒ *Location*: Subsidiary of Lightolier-Genlyte in Fall River, MA.

⇒ *Size*: 500 employees

⇒ *Annual Revenues*: $110 million (1990)

⇒ *Business*: Manufacturer of aluminum reflectors for Lightolier's track & recessed lighting product lines.

WHY WAS PROJECT PERFORMED?

The Aluminum Processing Company (APC), based in Fall River, Massachusetts, is a subsidiary of Lightolier-Genlyte, a national manufacturer and distributor of lighting products and accessories. APC fabricates aluminum reflectors for Lightolier's track and recessed lighting products.

As a subsidiary of Lightolier-Genlyte (L-G), APC manufacturing processes are guided by the L-G corporate environmental policy. To meet the corporate environmental objectives, APC recently embarked on a pollution prevention program in its fabrication operations. The initial pollution prevention project included assessing the replacement of a vapor degreasing system with an aqueous degreasing system. The Massachusetts Office of Technical Assistance (MA OTA) assisted APC carry out the analysis.

PROJECT DESCRIPTION

The manufacture of aluminum reflectors involves several steps. First, thin aluminum sheet is cut to a specified diameter and passed on to a machine where they are pressed into the reflector shape. The aluminum is coated with oil prior to entering the pressing process. The newly formed reflectors are then cleaned (degreased), buffed, and either plated or painted before packaging and shipping. Prior to this project, this manufacturing process involved the production of pollutants at three points:

- a petroleum-based oil was used in the forming machinery,
- the cleaning process employed vapor degreasers which used trichlorethylene (TCE), and
- the paint spray booths produce toxic air emissions.

The use of TCE, in particular, was a concern to APC. In 1990, the company used 73.5 tons of TCE at a cost of approximately $425 per ton. Of this, less than 10 percent was recovered and recycled, and a cost of $425 per ton. In addition, the presence of TCE took a significant amount of staff time due to monitoring the degreasers, manifesting the TCE sent out for recycling, reporting spill and leak incidents, and SARA Title three compliance reporting. In addition, the presence of TCE required that all employees receive 8 hours of annual training. Finally, every 50 gallon drum of TCA required about 20 minutes to label upon both receiving and shipping.

In an effort to tackle all three problems simultaneously, APC decided to substitute a non-petroleum-based oil in the forming machinery and replace one TCE-based degreaser with an aqueous solution model. Another degreaser was replaced with an integrated aqueous

degreaser/electrostatic powder coater unit. The powder coater is a method of applying a coating that eliminates most of the emissions associated with spray painting.

ANALYSIS The costs associated with purchasing and installing the new equipment is estimated at $155,365, of which $134,670 can be capitalized and depreciated over the life of the project. Annual operating and maintenance costs associated with the new equipment total $2,000. In addition, annual detergent purchase costs for the aqueous degreaser total $10,500.

COST CONSIDERATIONS

	Year One Savings
Solvent Purchase	$31,104
Solvent Disposal	$3,120
Eliminated Maintenance	$20,000
Labor	$11,850
Reduced Training	$900
Total Savings	**$66,974**
	Year One Costs
Operating/Maintenance	$2,000
Detergent Purchases	$10,500
Total Costs	**$12,500**

The annual cost savings associated with discontinuing the current process are greater than the annual costs associated with the new equipment. The elimination of TCE purchase saves $31,104 annually. Elimination of spent solvent disposal saves $3,120. Annual cost savings from eliminating maintenance for the old system are approximately $20,000 per year. Labor associated with TCE (incident reporting, monitoring/manifesting, labeling) are eliminated, saving $11,850 annually. In addition, the absence of TCE reduces the time needed for mandatory employee training, resulting in a $900 savings. Starting in year two, APC saves $1,100 annually in reduced regulatory fees paid to Massachusetts under the State's Toxic Use Reduction Act.

Finally, the installation of the new equipment eliminates the need for an unavoidable overhaul of the current equipment. This saves $40,000 in year two.

FINANCIAL PARAMETERS The analysis uses a discount rate of 15 percent, an inflation rate of 5 percent, a net tax rate of 39 percent, and straight line depreciation over a ten year period.

FINANCIAL RESULTS The 10 year net present value of the project is $101,292.

CONTACT Not provided.

SOURCE Northeast Waste Management Officials' Association and the Massachusetts Office of Technical Assistance, *Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects: Instructor's Guide*. 1994.

DEBOURGH

BUSINESS DECISION

CAPITAL INVESTMENTS

Are the following investments justified: (1) conversion from a high solids, baked enamel paint to TGIC polyester powder coatings; and (2) insulation of paint drying and curing ovens.

BUSINESS BENEFITS

For an initial investment of $289,029, DeBourgh saves $142,673 in operating costs in the first year. The discounted payback period is 4.17 years.

COMPANY PROFILE

⇒ *Location*: La Junta, CO

⇒ *Size*: 80 employees

⇒ *Annual Revenues*: $6 million

⇒ *Business*: Manufacturer of all-welded athletic and corridor lockers for schools and industry.

WHY WAS PROJECT PERFORMED?

DeBourgh Manufacturing Company is located in La Junta in Southeastern Colorado. The firm manufactures all-welded athletic and corridor lockers for schools and industry. DeBourgh has 80 employees, and its annual sales are around $6 million.

DeBourgh has an active resource management program responsible for finding ways to increase profits through pollution prevention and energy efficiency improvements. DeBourgh is a partner in the DOE Climate Wise program.

PROJECT DESCRIPTION

DeBourgh has also participated in the DOE Energy Conservation/Pollution Prevention Assistance for Industry program. A 1995 assessment performed by Colorado State University (CSU) helped DeBourgh personnel identify a number of pollution prevention and energy efficiency projects that offered and increases in productivity and profit.

The project analyzed here is a combination of two recommendations from the CSU report. The report recommended that DeBourgh (1) convert from a high solids, baked enamel paint to TGIC polyester powder coatings and (2) that the paint drying and curing ovens be insulated.

Together these efforts demonstrate the effects of materials substitution and process improvements on raw materials and energy usage, waste disposal, and other operating costs. DeBourgh completed the paint conversion in February-March, 1996 and the oven insulation modification in April, 1996. Both projects were financed internally.

ANALYSIS

The powder coating system installed by DeBourgh is a feature-enhanced, custom designed, semiautomatic system with oscillating spray guns and three manual stations. The system is used for roughly 75% of DeBourgh's production (the remaining 25% of products require liquid paint). The new electrostatic system doubles DeBourgh's painting capacity and reduces the number of rejects by almost 50% with absolutely no hazardous emissions to the outside environment. The total cost of the powder coating system, including installation, delivery, associated upgrades to the fire system, and purchasing expenses, is $289,029.

The oven insulation reduces heat loss from the existing paint drying and curing ovens. Including installation, the cost is $18,340.

A variety of annual cost savings are associated with the conversion from liquid (solvent-based) paint to powder paint. First—although the costs per unit of powder paint and liquid paint are similar—less powder paint is wasted because it has a higher transfer efficiency, thus less is

purchased. Powder paint's higher transfer efficiency also allows DeBourgh to replace the paint booth air filters less often. DeBourgh expects no change in paint storage costs or in paint equipment electricity use.

COST CONSIDERATIONS

	Year One Savings
Raw Materials	$39,000
Labor	$73,000
Waste Management	$12,000
Utilities	$14,673
Regulatory Compliance	$4,000
Total	**$142,673**

Powder paint equipment can be cleaned with compressed air, so DeBourgh reduces its purchases of xylene, which is used as a cleaning solvent for the liquid paint equipment. DeBourgh has an in-house solvent recycling unit that allows xylene to be reused, but the recycling process produces a hazardous sludge waste. This waste is regulated under RCRA, and is expensive to dispose. The reduction in solvent use allows DeBourgh to save on these disposal costs, regulatory paperwork, storage, and liability—as well as on the electricity and labor required by the recycling unit.

Other labor cost savings result from increased painting automation and reduced paint booth cleanup. Worker health and productivity should also improve, because there will be fewer hazardous air emissions from the liquid paint and cleaning solvent (powder paint has no air emissions). In addition, the reduction in air emissions allows DeBourgh to save on annual air emissions fees, air quality monitoring, regulatory paperwork, and plant air ventilation (which includes heating the make-up air).

In total, DeBourgh is able to quantify $132,463 of savings associated with the powder coating system. However, this figure does not include unquantified savings such as improved throughput, quality, and productivity; reduced liability, storage costs, and regulatory paperwork; and reduced worker exposure to VOC emissions. The oven insulation reduces DeBourgh's reliance on natural gas by $10,210 annually.

FINANCIAL PARAMETERS The analysis uses a project lifetime of 10 years, real cost of capital of 9%, a net tax rate of 39%. Capital costs are depreciated over 10 years using the straight line method.

FINANCIAL RESULTS The 10-year NPV is $264,865; the 10-year IRR is 26.8%; the discounted payback period is 4.17 years.

CONTACT Deborah Savage, Tellus Institute, (617) 266-5400.

SOURCES Colorado State University Industrial Assessment Center, *Energy Conservation & Pollution Prevention Assessment Report No. CO0332*. March 1995.

Savage, Deborah, and David Miller, "Workshop on Innovative Financing Results". Originally presented at the "Energy Efficiency & Pollution Prevention" conference sponsored by the Department of Energy. Denver CO, January 23, 1997.

HYDE TOOLS, INC.

BUSINESS DECISION

CAPITAL INVESTMENTS

Analysis of the purchase of system to recycle wash and rinse water, and quench oil from a heat treating process line.

BUSINESS BENEFITS

The initial investment of $20,055 accrues annual savings of $9,360. The 10 year net present value of the investment is $14,601.

COMPANY PROFILE

⇒ *Location*: Southbridge, MA

⇒ *Size*: 250 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Family-owned manufacturer of surface preparation and maintenance hand tools.

WHY WAS PROJECT PERFORMED?

Hyde Tools is a third generation, family-owned manufacturer of a range of surface preparation and maintenance hand tools. The company is a major employer in Southbridge, and has always striven to provide comfortable working conditions for its employees. The company's purchasing manager has taken an active interest in pollution prevention and Hyde, and has implemented a number of low-tech low-cost pollution prevention projects.

In 1990, the company set a goal of zero discharge by 1992. The plan to attain the goal had a number of components, many of which were intended to reduce the use of town water and sewage services. The company first decided to address discharges from the heat treatment process line for the company's knives and scrapers. The Massachusetts Office of Technology Assistance helped the company carry out a total cost analysis (TCA) of this project.

PROJECT DESCRIPTION

Hyde Tools manufactures a number of wall scrapers and blades in several different sizes and shapes. All of these blades are made of carbon steel, and undergo a heat treatment process to improve the performance of the material. This process is as follows: blades are loaded onto racks which take submerge them in a tank filled with molten salt (1600–1800^{o}F). The rack is then plunged into a 500 gallon tank of quench oil in order to cool the blades. The blades are then washed and rinsed twice to remove the oil.

The heat treatment process accumulates 12 drums of equal parts water and oil every six weeks. The waste is sent off site for reclamation and water removal. The company determined that in-process recycling offered the best solution to eliminate this discharge. This recycling system would not only recycle wash and rinse waters, but would also recycle the quench oil. The proposed system would reduce the cost if reclaiming the quench oil, eliminate the pumping of oil to the drum, and recirculate wash and rinse water to the extent feasible, without discharging to the sewage system.

ANALYSIS

The total expenditure for the purchase of the filtration and recycling equipment is $20,055. This price includes training in the use and monitoring of the system. Installation costs amount to about $5,000. In addition, a float switch and associated alarm system (for the purpose of monitoring fluid levels) need to be purchased ($250) and installed ($500).

Annual operating costs associated with the new system total $3,900, and comprises purchase of filtration medium ($1,300) and disposal of used filtration medium ($2,600).

These increased costs are offset by annual savings of $13,260 incurred due to discontinuing the current process. This total is embodies the following: 20 percent reduction in water usage ($8,760); permit fee savings incurred due to moving from a major to low discharge water user ($4,200); and, savings associated with reduced testing requirements ($300).

COST CONSIDERATIONS

	Annual Savings
Water Usage	$8,760
Reduced Permit Fees	$4,200
Reduced Testing	$300
Total Savings	**$13,260**
	Annual Costs
Filtration Medium	$2,600
Filter Disposal	$1,300
Total Costs	**$3,900**

FINANCIAL PARAMETERS The analysis uses the following economic parameters: 40 percent net tax rate; 15 percent discount rate; 5 percent inflation; straight line depreciation over ten years.

FINANCIAL RESULTS The 10 year net present value of the investment is $14,601. The project was approved on the basis of its quantitative and qualitative merits, and installed in May 1991.

INSTITUTIONAL CHANGE The success of this project demonstrated to Hyde the potential benefits that pollution prevention projects can provide. The results of this project encouraged Hyde to carry out several additional pollution prevention projects, including the following:

- Change in procedures to prevent plant spills from being discharged into the town's sewer system;
- Elimination of the use of 1,1,1 trichloroethane;
- Replacement of kerosene with a water-based cleaner for removing polishing compounds ($12,825 annual savings);
- Replacement of fluorescent lighting with high pressure sodium or metal halide lighting ($48,000 annual savings)

CONTACT Not provided.

SOURCE Northeast Waste Management Officials' Association and the Massachusetts Office of Technical Assistance, *Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects: Instructor's Guide*. 1994.

A JEWELRY COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Is a capital investment in a chemical-reducing ethyl acetate still financially justified?

BUSINESS BENEFITS

For an investment of $16,000, the company would realize annual operating savings of $18,000 in each of the first five years.

COMPANY PROFILE

⇒ *Location*: Sutton, MA

⇒ *Size*: 500 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Manufacturer and distributor of jewelry, personal leather goods, and personal accessory items

WHY WAS PROJECT PERFORMED?

This company has long demonstrated a genuine concern for the well-being of its employees and its community. It has taken an active posture in addressing the environmental concerns of the town in which it operates, often acting well in advance of regulations. Although the facility was in compliance with all applicable regulations, the Environmental Manager was eager to reduce the volume of ethyl acetate used to strip lacquer from its plating racks. The high cost of both the purchase and disposal of the ethyl acetate presented an opportunity for cost savings.

The analysis was conducted by the company's VP of Environmental Affairs with the help of a Massachusetts Office of Technical Assistance representative. A previously submitted proposal for an investment to enable reduced ethyl acetate use had not received corporate approval, despite an estimated 11-month payback. The VP wanted to resubmit the proposal using a more formal financial analysis. The study was included in a training manual for using financial assessment for pollution prevention projects prepared by the Northeast Waste Management Officials' Association.

PROJECT DESCRIPTION

To produce jewelry with a white finish, the facility had determined that silver was the best metal in terms of both aesthetics and manufacturability. To prevent tarnishing, silver-plated pieces must be coated in lacquer prior to finishing. To perform this process, the pieces are placed in plating racks that are dipped in lacquer. After the pieces have been removed, the racks are stripped of the lacquer using ethyl acetate. Once the ethyl acetate is exhausted, it is disposed of as hazardous waste.

The facility investigated options for reducing the volume of ethyl acetate it purchased and disposed of and decided that a solvent recovery still offered the best solution. Several vendors presented bids, among which was a $14,000 unit with a $2,000 installation cost that the facility chose. The new system would be placed in-line with the lacquer dipping operation and would allow the ethyl acetate to be recovered and reused until it lost its ability to strip the lacquer.

ANALYSIS

The investment in a solvent recovery still was evaluated using a financial assessment method intended to include environmentally-related costs that are often omitted from investment analyses. The only initial investment cost was the purchase of the still and its installation. Annual operating cost savings from anticipated reductions in ethyl acetate purchases, disposal of spent ethyl acetate, manifesting labor, and Toxics Use Reduction Act fees. The additional costs from operation of the still are an increase in utility costs to power the equipment and costs of disposing the still bottoms.

A JEWELRY COMPANY

FINANCIAL PARAMETERS

The analysis incorporates these costs in a discounted cash flow model that assumes a five-year useful life of the equipment. The model uses a discount rate of 15% to represent the firm's cost of capital, an inflation rate of 5%, and a corporate income tax rate of 40%. The model also considers the tax savings from a straight-line depreciation of the solvent recovery still investment.

COST CONSIDERATIONS

	Year One Savings
Materials	$ 19,000
Chemical Disposal	$ 11,000
Manifesting	$ 400
Compliance	$ 1,000
Total Savings	**$ 31,400**
	Year One Costs
Waste Disposal	$ 13,000
Utilities	$ 200
Total Costs	**$ 13,200**

FINANCIAL RESULTS

The discounted cash flow analysis yields a net present value (NPV) of $28,279 for the initial $16,000 investment. Compared to the 11-month simple payback calculated in the original company analysis, the discounted payback of this analysis shows that the investment would pay for itself in less than seven months. The weekly operating savings expected from the still installation is estimated to be over $300 just from purchase and disposal costs. The inclusion of depreciation tax savings contributes over $4,000 to the investment's NPV.

CONTACT

Northeast Waste Management Officials' Association (617) 367-8558
Massachusetts Office of Technical Assistance (617) 727-3260

SOURCE

Northeast Waste Management Officials' Association and the Massachusetts Office of Technical Assistance, *Improving your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects: Training Manual*. 1994.

MAJESTIC METALS

BUSINESS DECISION

CAPITAL INVESTMENTS

Is the capital investment in high volume, low pressure spray guns to replace conventional paints spray guns justified?

BUSINESS BENEFITS

For a capital investment of $3,002, Majestic Metals sees operating costs savings of $40,298 in the first year.

COMPANY PROFILE

⇒ *Location*: Denver, Colorado

⇒ *Size*: 100 employees in 2 shifts

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Manufacturer of precision sheet metal primarily for the medical and electronics industries.

WHY WAS PROJECT PERFORMED?

Majestic Metals, Inc., located in Denver, Colorado, is a precision sheet metal manufacturer primarily serving the medical and electronics industries. Majestic Metals, Inc., has a complex operation that includes shearing, punching, forming, welding, painting, and silk-screening. Over 750,000 parts are produced annually, and more than 1,400 parts are in the facility at any given time. The firm has a workforce of about 100 and works two shifts.

Majestic Metals, Inc., is committed to pollution prevention, waste minimization, and energy efficiency, and believes this commitment can contribute substantially to the bottom line.

As a result of this commitment, Majestic Metals realizes annual savings of over $40,000 and is recognized by customers and within the community as a leader in this area. The company has developed major new customers as a result of its environmental efforts. Worker safety programs have reduced accidents by 75 percent in the last four years and the company reports productivity gains due to improved employee awareness and participation in pollution prevention projects.

Majestic Metals is a partner in the DOE Climate Wise program. Majestic Metals has also participated in the DOE Energy Conservation/Pollution Prevention Assistance for Industry program. A 1992 assessment performed by Colorado State University (CSU) helped identify a number of pollution prevention and energy efficiency projects that offered increased production capacity and lower cost through improved process design and recycling of valuable materials. The paint gun conversion discussed in this snapshot is one of the modifications recommended in the CSU report.

PROJECT DESCRIPTION

The project in this snapshot is the replacement of conventional paint spray guns with high volume, low pressure (HVLP) spray guns for painting parts and completed systems. This equipment change, financed with internal funds, allowed significant reductions in both raw material usage and volatile organic compound (VOC) emissions from solvent evaporation.

Painting consists of three basic steps: surface preparation, paint application, and cleaning. In preparing a part for painting, workers manually plug holes and tape over sections that will not be painted. Workers also mix the base paint with solvent mixing materials to achieve the proper viscosity. Paint application occurs in a three-sided paint booth, which is equipped with a large (8'x10') filter to remove paint particles from the air. Parts are carried into the booth on an overhead conveyor system, and painted using paint spray guns aimed in the direction of the

filter. The paint guns are cleaned before each color change by spraying pure solvent through them.

COST CONSIDERATIONS

	Year One Savings
Raw Materials:	
Paint	$27,170
Mixing Materials	$3,532
Paint Booth Filters	$8,136
Labor:	
Paint Gun Washing	$730
Paint Mixing	$730
Net Savings	**$40,298**

ANALYSIS The HVLP paint guns installed by Majestic Metals transfer paint to parts more efficiently than conventional paint guns because the paint travels through the air at lower velocity and is less likely to bounce off the surface being painted. HVLP paint guns have a transfer efficiency rating of roughly 55%, while conventional guns have a rating of about 30%. The total cost of the seven HVLP guns is $3,002. Installation is simple and is not significant enough to be included in the analysis.

Majestic Metals achieves a variety of savings in annual operating costs due to the higher efficiency of HVLP paint guns. Most importantly, HVLP paint guns use less paint and mixing materials than conventional guns. HVLP guns also reduce the burden on paint booth air filters, so that they can be replaced less often. Together, the annual cost of raw materials are reduced by $38,838—from $82,266 to $43,428. Like conventional paint guns, HVLP guns are cleaned with solvents (produced by Majestic Metals' on-site solvent recycling system), however HVLP paint guns require less labor to clean than conventional guns. There is also a labor savings due to reduced paint mixing time. Together, annual labor costs are reduced by $1,460—from $5,100 to $3,640. It does take slightly longer to paint parts with HVLP guns. This does not present a throughput problem, however, because the primary bottleneck in the paint department is in preparing and masking parts before they are painted.

Because paint use declines, solvent air emissions also decline, contributing to improved worker health and productivity. Estimated air emissions are reduced by 5,040 pounds per year. The HVLP paint gun project also plays a role in maintaining Majestic Metals' P2 leadership role: the company reports that is has gained at least two major new customers from publicity surrounding its various P2 efforts. These effects are not quantified.

FINANCIAL PARAMETERS The analysis uses a project lifetime of 8 years, cost of capital of 12%, a 3.3% inflation rate, a net tax rate of 39%. Capital costs are expensed.

FINANCIAL RESULTS The 8-year NPV is $140,900; the 8-year IRR is 906%; the discounted payback period is 0.12 years.

INSTITUTIONAL CHANGE Majestic Metals experience with ECA in this case has had a moderate impact on the company's internal financial analysis and other practices. As a custom manufacturer, Majestic Metals does little product design, so most analysis is related to process changes. Environmental issues and new equipment are high priority. Longer time horizons are of "interest" to the company, but stated guidelines have not been modified. Indicators now calculated include raw material considerations.

CONTACT Deborah Savage, Tellus Institute, (617) 266-5400.

SOURCES

Colorado State University Waste Minimization Assessment Center, *Waste Minimization Assessment Report No. 56-33*. July 1992.

Savage, Deborah, and David Miller, "Workshop on Innovative Financing Results". Originally presented at the "Energy Efficiency & Pollution Prevention" conference sponsored by the Department of Energy. Denver CO, January 23, 1997.

Denton R. Johnson, Majestic Metals, November 12, 1997.

MANUFACTURER OF PRECISION METAL PARTS

BUSINESS DECISION

CAPITAL INVESTMENTS

Which of three possible alternatives to the CFC degreaser is best: (1) alkaline cleaner with off-site disposal; (2) alkaline cleaner with discharge to sewer; (3) alkaline cleaner with in-house recycling?

COMPANY PROFILE

⇒ *Location*: Massachusetts

⇒ *Size*: 16 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Milling, tapping, reaming, and lathe work with brass, aluminum, stainless, or cast metals.

BUSINESS BENEFITS

For an investment in equipment of $11,400, the manufacturer realizes an annual cash flow reduction of over $25,000. An investment of an additional $4,000 in recycling equipment realizes an additional cash flow reduction of about $1,000. The 8-year net present values of the three alternatives were: (1) $77,400; (2) $73,531; (3) $76,926.

WHY WAS PROJECT PERFORMED?

This manufacturer needs to clean petroleum-based threading and cutting lubricants, as well as water-based machine tool coolants from large quantities of small parts made of brass, aluminum, stainless steel, or cast metals. Due to both regulatory considerations and the company president's commitment to environmental stewardship, the company wished to identify an alternative to its CFC-based vapor degreaser. P2 Consulting conducted a comprehensive financial analysis comparing the CFC-based cleaning system with an alkaline aqueous cleaning methodology. Three disposal options for the waste cleaner were analyzed: (1) off-site disposal; (2) discharge to sewer; (3) in-house recycling.

PROJECT DESCRIPTION

In 1989, this small manufacturer of precision metal parts used 2,673 pounds of Freon TF in its vapor degreaser for cleaning lubricants and coolants from product. Purchases of this CFC cleaning material cost the company $27,907 annually. In 1990, the company began looking for an alternative cleaning process. Although continuing to use the CFC-based vapor degreasing process remained financially feasible, it was ruled out because of regulatory considerations and because of the company president's commitment to environmental stewardship.

Research and experimentation revealed that a mild alkaline detergent was effective for cleaning. Three options were available for disposing the waste alkaline cleaner: (1) off-site disposal; (2) discharge to sewer; (3) in-house recycling.

ANALYSIS

In addition to the annual CFC purchase cost of $27,907, the manufacturer also faced off-site disposal costs of $365 per drum of waste CFCs. At the time of the analysis, the facility was considered a "very small" generator of wastes under Massachusetts law. Thus, time and costs associated with paperwork were minimal.

The CFC degreaser required maintenance several times a year at an estimated annual cost of $320. Other miscellaneous costs associated with the CFC degreaser bring its total annual operating cost to $28,627.

MANUFACTURER OF PRECISION METAL PARTS

Moving to the alkaline cleaning system requires a capital expenditure of $11,400, and results in an annual savings of the $28,627 operating costs associated with the CFC degreaser. These savings are offset somewhat by costs associated with the disposal options. These costs are described in detail below.

COST CONSIDERATIONS

	Annual Savings
CFC Degreaser Costs	$28,627
Total Savings	**$28,627**
Disposal Option	**Annual Cost**
Off-Site Disposal	$1,645
Discharge to Sewer	$2,857
Recycling	$810

(1) Sending the Waste Cleaner Off Site

Because the facility is already shipping other waste off site, little additional effort would be required to implement this option. However, the increase in waste generated would change the facility's status from that of a "very small" to a "small" quantity generator, meaning greater exposure to liabilities. Annual costs associated with this option total $1,645, and include an annual laboratory testing fee of $400 to assure the hauler of waste specifications, a disposal fee of $210, and maintenance costs of $860.

(2) Discharging the Waste Cleaner to the Sewer

The company estimated the waste cleaner would need to be discharge six times a year. The addition of spent cleaner would not significantly change the facility's discharge flow to the local sewage treatment plant. As a good-faith gesture on the company's behalf, as well as a protection against potential legal challenges, this option would require a $300 laboratory testing fee for each discharge, totaling $1,800 a year. Other costs would be substantially the same as for the off-site disposal option, resulting in total annual costs of $2,857.

(3) Recycling the Waste Cleaner

Recycling the waste cleaner would require the purchase of a small ultrafiltration unit at a cost of $4,000. Not only would this enable the recycling of the waste clean, but it would also allow the recycling of spent machine coolant, resulting in a net annual savings of $265. Labor and other costs offset this savings to result in net annual costs of $810.

FINANCIAL PARAMETERS The analysis uses straight-line depreciation, a 40% corporate tax rate, and a 10% discount rate.

FINANCIAL RESULTS The switch to the alkaline cleaning system results in an annual savings of $28,627. This savings is offset by annual disposal costs of $810 to $2,857, depending on the option selected, resulting net annual savings of $25,770 to $27,817. The 8-year net present values of the three options were: (1) $77,400; (2) $73,531; (3) $76,926. The company implemented option (3). The company felt the overall environmental benefits were a sound business reason to select this option.

CONTACT Not provided.

SOURCE Kennedy, Mitchell, "Getting to the Bottom Line: How TCA Shows the Real Cost of Solvent Substitution." *Pollution Prevention Review.* Spring 1994.

A METAL FABRICATION COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Study of an investment in equipment to separate water from paint washwater and oil/water wastes to reduce disposal costs.

COMPANY PROFILE

⇒ *Location*: New Jersey

⇒ *Size*: 200-300 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Metal fabrication, primarily for a computer manufacturer.

BUSINESS BENEFITS

For and initial investment of $19,659, this company saves $5,234 in the first year. Using total cost assessment (TCA) method; simple payback is 3.8 years. The company's initial analysis yields a payback period of 4.3 years.

WHY WAS PROJECT PERFORMED?

This privately owned company operates as a metal fabrication shop for a major computer manufacturer (which represents 90 percent of the company's sales), and an office furniture maker. Because of this close business link, the two customers have a strong influence on the company's processes and materials. For example, the office furniture manufacture has specified and paid for the installation of a powder coating line. Similarly, at the recommendation of the computer maker, the company replaced low efficiency spray equipment with high efficiency equipment.

The company's metal fabrication and painting activities generate a variety of waste streams, including: scrap metal; spent solvent from vapor degreasing; nitric acid and sodium hydroxide from etchants; cutting oil and fluid from metal working; lubrication oil; ammonium hydroxide from water-based paint clean-up; organic solvents from paint clean-ups; fiberglass filters coated with paint from spray boots; and waste paint from overspray, cleanup, and expired inventory. Approximately $60,000 is spent annually for waste disposal.

Management learned that a similar company was using a paint/water separator to reduce washwater disposal costs. After some preliminary investigations, management decided to prepare a cost analysis of the project. The TCA was conducted as part of a pilot to study the potential for TCA application in New Jersey.

PROJECT DESCRIPTION

The company generates about 1,600 gallons of water-based paint washwater annually in the course of flushing spray paint guns. This waste stream (95% water, 4% ammonia, 1% water-based paint pigments) is currently disposed of by the company in an incinerator at an annual cost of $7,022. In addition, the company's metal grinding operations generates about 2,900 gallons of water soluble oil from lubrication and cooling. This waste stream is also disposed of by incineration at an annual cost of $1,884.

The project under evaluation is a 100 gallon batch system for separating the waste water into three components: oil, paint solids, and filtered water warranted to meet discharge standards. The system consists of two tanks, stacked vertically with a filter between them. Waste water is mixed with treatment chemicals in the upper tank. Once flocculation has occurred, a valve on the bottom of the top tank is opened, and the sludge is captured in a filter.

A METAL FABRICATION COMPANY

ANALYSIS The preliminary financial analysis performed by the company calculates the initial purchase equipment costs as $18,880. In addition, $779 worth of materials and supplies (i.e., chemicals and filter paper) are required as working capital, making the total investment $19,659. Increased annual costs associated with the separator include $218 in materials and supplies (i.e., chemicals and filter paper), $136 in increased utility costs, and $714 in increased labor costs. These annual costs are offset by a $5,651 savings in waste management costs. The net annual cost savings are estimated at $4,583.

COST CONSIDERATIONS

	Year One Savings
Waste Management	$6,135
Regulatory Compliance	$194
Total Savings	**$6,329**

	Year One Costs
Materials	$218
Utilities	$163
Labor	$714
Total Costs	**$1,095**

The in-depth total cost assessment (TCA) reveals additional costs and savings. Additional investment costs total $74—$15 for installation and $59 for training—for a total of $19,733. Additional annual operating costs revealed by TCA total $221, and include additional waste management costs ($138), additional utility costs ($27), and additional regulatory compliance costs ($29). Additional annual savings revealed by TCA total $845, and include: additional reduced waste management costs ($622) and reduced regulatory compliance costs ($223). The net annual cost savings are estimated at $5,234.

FINANCIAL PARAMETERS The analysis uses a 12 percent cost of capital. The net income tax rate is assumed to be 48 percent. Capital is depreciated over seven years, using the double declining balance/straight line method.

FINANCIAL RESULTS The company's initial analysis yields: 15-year NPV of $9,332; 15-year IRR of 20%, and payback of 4.3 years. Using total cost assessment (TCA) method, the analysis is similar, although slightly more favorable: 15 year net present value (NPV) is $12,436; the 15 year internal rate of return (IRR) is 23%; simple payback is 3.8 years.

CONTACT Deborah Savage, Tellus Institute (617)266-5400.

SOURCE White, Allen L., Monica Becker, and James Goldstein, *Alternative Approaches to the Financial Evaluation of Industrial Pollution Prevention Investments*. Prepared for NJ DEP. November 1991. **Also:** White, Allen L., Deborah Savage, and Monica Becker, *Revised Executive Summary*. June 1993.

PRODUCTION PLATING, INC.

BUSINESS DECISION

CAPITAL INVESTMENTS

Are capital investments in a less-polluting powder recovery unit and rinsewater recycling system financially justified?

BUSINESS BENEFITS

An $8,000 investment yielded annual operating savings of $10-15,000. For a second investment of $129,000, Production Plating would realize annual operating savings of over $50,000.

COMPANY PROFILE

⇒ *Location*: Mukilteo & Redmond, WA

⇒ *Size*: 100 employees

⇒ *Annual Revenues*: $5,000,000

⇒ *Business*: Metal finishing, powder coating

WHY WAS PROJECT PERFORMED?

Production Plating is committed to making pollution prevention (P2) investments to improve its environmental performance while improving operating efficiency and reducing costs. The company believes these initiatives to reduce pollution will make it more competitive and better positioned to respond to future regulatory requirements. The company had recently invested in a powder coating capture and reuse system at the Redmond facility and was considering a rinsewater recycling system at the Mukilteo site. The company hoped to use this analysis to assess the economic viability of the projects.

The analysis was conducted jointly by the company and the Pacific Northwest Pollution Prevention Resource Center (PPRC) to assess the feasibility of total cost assessment (TCA), a decision method designed to enhance capital budgeting decisions in connection with P2 projects. The study was undertaken in response to needs identified by the local metal finishing industry to have access to an effective, practical P2 cost evaluation method. Production Plating volunteered its proposed projects for analysis.

PROJECT DESCRIPTION

The first investment was for a powder coating recovery system. Powder coating is a dry painting process in which the powder is applied to metal parts using a spray gun. The recovery system is coupled to the spray booth's existing filtration system to capture sprayed powder and return it to the spray gun feed container for reuse. The system reduces the total amount of powder needed and the amount of spent powder that has to be sent to landfills as non-hazardous waste.

The second investment was for plant-wide plating rinsewater recycling. The facility had established a goal to reduce the amount of water used and discharged by the rinsewater process. The water is collected in sludge tanks as non-heavy metal, acid/chrome, mildly alkaline/cleaner, or alkaline. These four waste streams go through various treatment and disposal processes that physically occupy five percent of the facility's operating space. An alternative to the current processes was a rinsewater ultrafiltration recycling system that would reduce the volume of water discharged by 90%, increase floor space, and reduce treatment chemical handling and use.

ANALYSIS

Both projects were evaluated using Total Cost Assessment (TCA), a method to enhance capital budgeting decisions in connection with P2 projects. The powder coating recovery system was analyzed in terms of its costs for coating one representative part for which pre- and post-system data were available. The costs of the unit and of subsequent filter replacements

and the cost savings from less wasted powder, including lower purchase and disposal costs, were the key cost components included in the analysis. Also included was a tax exemption for which Production Plating was qualified. Contingent/liability and less-tangible costs – including materials handling, future liability, corporate image, customer response, and market share – were considered qualitatively to provide a broader perspective on less tangible costs and savings. The cost of the recovery unit was depreciated on a straight-line basis.

COST CONSIDERATIONS

Powder Recovery	Year One Savings
Paint Savings	$ 10,900
Total Savings	**$ 10,900**

Rinsewater System	Year One Savings
Labor	$ 15,600
Materials	$ 48,400
Sludge Disposal	$ 5,000
Fines/Penalties	$ 3,000
Total Savings	**$ 72,000**

The rinsewater ultrafiltration system was evaluated by comparing current operating costs with expected costs of the new system. The main cost components for this analysis were treatment chemicals, worker and management labor, monitoring costs, filter costs, current and future violation penalties, testing and reporting labor, and sludge disposal costs. The company also qualitatively considered many less tangible benefits such as improved air quality, lower accident risk, freed-up work space, reduced liability, fewer worker injuries, and enhanced employee morale. The cost of the system itself was included and depreciated on a straight-line basis.

FINANCIAL PARAMETERS The analysis uses an inflation rate of 5% and a discount rate of 15%.

FINANCIAL RESULTS The powder recovery system investment yielded a five-year net present value (NPV) of $18,334 with a discounted payback under 15 months. The analysis assumed a certain production level, paint cost, powder savings, and equipment life. A sensitivity analysis showed the production level to be the dominant profitability driver; a reduction by 50% in the assumed production level would raise the payback to 2.5 years.

The annual cost of the existing rinsewater system was estimated at approximately $123,000, driven largely by water usage. Projecting over a ten-year period, a TCA analysis of the proposed ultrafiltration system yielded a NPV of $168,697 with a discounted payback period of 2.3 years. This analysis also used an inflation rate of 5% and a discount rate of 15%.

CONTACT Chris Montovino, PPRC (206) 223-1151
Mark Wilsen, Production Plating, Inc. (206) 347-4635

SOURCE Pacific Northwest Pollution Prevention Resource Center, *Analysis of Pollution Prevention Investments Using Total Cost Assessment: A Case Study in the Metal Finishing Industry*. July 1996.

WILLIAMS PRECISION VALVE COMPANY, INC.

BUSINESS DECISION

CAPITAL INVESTMENTS

Study of a closed-loop system on zinc phosphate plating line to eliminate plant's discharge to sewer.

BUSINESS BENEFITS

The purchase cost of the waste water recirculation system is $55,000. Associated net annual savings total $26,272.

COMPANY PROFILE

⇒ *Location*: U.S. subsidiary of European multinational with plants in Rundel and Fairhaven, MA

⇒ *Size*: ~1,000 employees

⇒ *Annual Revenues*: ~$150 million in sales in U.S. in 1990

⇒ *Business*: Manufacturer of precision industrial valves and actuators for chemical, pulp and paper, railroad, and oil industries.

WHY WAS PROJECT PERFORMED?

Williams Valve produces high performance valves that meet rigid specifications. Their products are used in critical operations where exacting tolerances must be adhered to. Williams operates at the high end of the valve market, where quality and service, rather than price, are the criteria of competition. It has positioned itself as a designer and supplier of one-of-a-kind products developed for highly specialized operations.

Williams operates under environmental guidelines provided by the corporate parent. Williams has translated these guidelines into a set of policies and practices that encourage a proactive approach to environmental management. The company has created a team of high level management personnel charged with overseeing environmental compliance and initiating pollution prevention initiatives.

PROJECT DESCRIPTION

The primary source of wastewater in Williams' production operations are associated with the process of coating parts with zinc phosphate to inhibit corrosion. The processes consists of a series of cleaning and rinsing step both prior to and following the actual zinc phosphate plating itself. The waste stream from this process is combined with other wastestreams prior to pretreatment and discharge to POTW for treatment. The combined wastestream contains alkaline cleaners, synthetic oils, fats, zinc traces, grease, and an unacceptable pH level. Pretreatment skims oil, adjusts pH, and allows sludge to settle out. Sludge and oil skimmings are manifested as regulated recyclable material.

In early 1991, the company was facing the possibility that new regulations on zinc discharges might require additional treatment in the future. In order to eliminate this uncertainty, as well as reduce water and sewer costs, the company investigated installation of a closed-loop wastewater treatment system.

Based on technical information received from vendors, the company selected a proposal from a company specializing in water purification systems for further consideration. The particular technology had never been installed on a zinc phosphate plating line. Nonetheless, the vendor had tested Williams effluent, and determined that its treatment process was effective. Williams asked the Massachusetts Office of Technical Assistance to help analyze the financial impact of the project.

ANALYSIS

WILLIAMS PRECISION VALVE COMPANY, INC.

The purchase cost of the waste water recirculation system is $55,000, including delivery and installation.

In addition, the new system will require $20,000 in increased annual operation and maintenance costs, as well as the annual purchase of $5,000 worth of filtration medium.

These cost increases are offset by several cost reductions due to discontinuing the current process. These cost reductions total $51,272, comprise the following: reduced water bill ($4,800); elimination of sludge disposal ($11,185); elimination of operation and maintenance associated with the old system ($28,800); elimination of lab analyses of discharge ($810); elimination of sampling ($2,640); reduced regulatory fees ($2,400); elimination of chemical purchases ($637).

COST CONSIDERATIONS

	Annual Savings
Water Use	$4,800
Sludge Disposal	$11,185
Operation & Maintenance	$28,800
Discharge Analyses	$810
Sampling of Discharge	$2,640
Regulatory Fees	$2,400
Chemical Purchases	$637
Total Savings	**$51,272**
	Annual Costs
Operation & Maintenance	$20,000
Filtration Medium	$5,000
Total Costs	**$25,000**

FINANCIAL PARAMETERS The financial analysis uses the following economic parameters: 40 percent net tax rate; 15 percent discount rate; 5 percent inflation; straight line depreciation over ten years.

FINANCIAL RESULTS The 10 year net present value of the investment is $54,913.

Despite this very attractive economic analysis, the company decided to *not* proceed with the closed-loop system. Because the system had not yet been tested on a full-scale zinc phosphate plating line, the company's environmental team thought it would be inappropriate to serve as a test site. There were also concerns that the technology might introduce variation into the production process that could have an impact on the quality of Williams' products. Because the company competes primarily on the basis of quality, it could not risk jeopardizing its competitive advantage.

Nonetheless, the company is continuing to investigate the closed loop concept, and is looking for examples of such systems installed on process lines similar to theirs.

CONTACT Not provided.

SOURCE Northeast Waste Management Officials' Association and the Massachusetts Office of Technical Assistance, *Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects: Instructor's Guide*. 1994.

A FLEXOGRAPHIC PRINTER

BUSINESS DECISION

CAPITAL INVESTMENTS

Is the capital investment in an in-line solvent recovery still to replace an existing mobile solvent recovery service justified?

COMPANY PROFILE

⇒ *Location*: Midwest United States

⇒ *Size*: 36 employees

⇒ *Annual Revenues*: $15 million

⇒ *Business*: Flexographic printing

BUSINESS BENEFITS

For a $26,200 initial investment, the company would realize annual operating savings of $24,537 in the first year, and $20,641 in subsequent years with a 57.34%. internal rate of return over 15 years. The 15-year net present value is $99,879. Payback period is 1.06 years.

WHY WAS PROJECT PERFORMED?

This flexographic printer upgraded its platemaking process in 1995 to eliminate the use of perchloroethylene, or perc, in order to "do the right thing environmentally" and to improve the work environment. The firm was considering replacing its existing mobile solvent recovery service with an in-line still for solvent recovery.

Tellus Institute cooperated with the flexographic printer to analyze this decision as a User's Guide case study for a Tellus P2/FINANCE software package. The printer benefited from having the results of the Total Cost Assessment (TCA) before making any purchase decisions.

PROJECT DESCRIPTION

The new platemaking process uses Optisol. A mobile service recycles the spent solvent on site every other month, recovering approximately 89% of the solvent as clean, reusable product. However, this service is costly and the recovery rate is not optimal.

Prompted by costly solvent recovery charges and increasing solvent purchase costs, this flexographic printer began examining options for reducing these costs. This printer occasionally works with another flexographic printer. The other printer has also upgraded to a perchloroethylene-free platemaking process, but instead of using a mobile recovery service, it recycles solvent using a distillation system with a recovery rate of at least 95%. Based upon the other printer's experience, this printer's technical director decided to explore the profitability of installing a distillation system to recycle spent solvent.

ANALYSIS

The investment analysis for conversion to an in-line solvent recovery still used a TCA, a method to enhance capital budgeting decisions with connection to P2 projects. TCA assured inclusion of costs which traditional cost analysis might have missed.

For the existing mobile solvent recovery service, the solvent purchase cost was based on the amount of solvent required every year to replace losses during the recycling process (assuming an 89% recovery rate) and losses to the air during the platemaking process (determined from the company's air emissions permit). The recycling cost was based on the total volume recycled per year, and the still bottoms disposal cost was based on the amount of solvent not recovered by the recycling process (11%).

For the distillation system under consideration, the purchase and other start-up costs were all incurred in the first year. The solvent purchase cost was based on a 95% recovery rate and took into account that 4 of the 10 inventory drums could be used up in Year 1 (as the new

system only requires 6 drums of inventory – after Year 1 those 4 drums must be purchased every year). The analysis assumed that losses to air remain unchanged. The still bottoms disposal cost was based on the amount of solvent not recovered by the still (5%). Annual operating costs for the distillation system also included maintenance (oil changes, replacement filters), and electricity cost. Labor (both operating and maintenance) and water costs will not differ significantly from those under the old system. Therefore, these costs are not included.

COST CONSIDERATIONS

	Year One Savings
Chemicals	$ 8,835
Disposal	$ 527
Mobile Recovery Service	$18,075
Total Savings	**$27,437**
	Year One Costs
Maintenance Supplies	$ 2,659
Electricity	$ 241
Total Costs	**$2,900**

FINANCIAL PARAMETERS The analysis used a cost of capital of 10%, a 4% inflation rate, a Federal tax rate of 38%, a State tax rate of 7.25%, a salvage value of $2,620 and used straight-line depreciation over 7 years.

FINANCIAL RESULTS The TCA for the company switching to the distillation system indicated it would realize annual operating savings of $24,537 in the first year, and $20,641 in subsequent years with a 57.34%. internal rate of return over 15 years. The 15-year net present value is $99,879. The payback period for the investment is 1.06 years.

The main savings from the switch would come from reduced purchase of chemicals, due to the higher recovery rate of the distillation system, as well as the elimination of the annual fee for the mobile recovery service. The capital investment in the distillation system, as well as the increased cost of maintenance and electricity required by this system, is more than offset by the savings.

CONTACT Karen Shapiro, Tellus Institute (617) 266-5400.

SOURCE Tellus Institute, *P2/FINANCE for Flexographic Printers: User's Guide*. 1996.

A SCREEN PRINTER

BUSINESS DECISION

CAPITAL INVESTMENTS

Is the capital investment in dry film imaging system to reduce the current service bureau charges and darkroom costs justified?

COMPANY PROFILE

⇒ *Location*: Not reported

⇒ *Size*: 40 employees

⇒ *Annual Revenues*: $3 million

⇒ *Business*: Screen printing

BUSINESS BENEFITS

For an initial investment of $31,300, the company realizes year one net savings of $139,390. The 5-year net present value (NPV) of the investment is $495,860. The 5-year internal rate of return (IRR) is 446%. Payback is 0.25 years.

WHY WAS PROJECT PERFORMED?

This screen printer is a digital shop; however, it does not have a high resolution output device. This requires the use of service bureaus to generate camera-ready art, and also the generation of positives from camera-ready art using gelatin silver photographic film. The company president began changes that would decrease its reliance on waste haulers and service bureaus, and thereby reduce the related costs. A dry film imaging system would enable the company to generate positives directly from a computer, not only reducing service bureau charges, but also potentially darkroom and waste disposal costs.

Tellus Institute cooperated with the screen printer to develop a User's Guide case study for a Tellus P2/FINANCE software package. The printer benefited from having the results of the analysis before making its purchase decision.

PROJECT DESCRIPTION

This screen printer is a digital shop—most jobs either come in on disk or are scanned into the computer. However, because the printer does not have a high resolution output device, it uses service bureaus to generate camera-ready art and proofs (as needed). Service bureau charges are approximately $89,000 per year.

The printer currently generates positives from camera-ready art using gelatin silver photographic film. Because the printer uses an on-site septic system, it is prohibited from disposing process water from its darkroom down the drain. Silver is recovered from washwater, and washwater and fixer are separately collected for off-site disposal.

Prompted by increasing waste disposal costs and costly service bureau charges, the company's president began examining production changes that would decrease its reliance on waste haulers and service bureaus. One option identified was the purchase of a dry film imaging system, enabling the shop to generate positives directly from a computer, and thus by-pass the darkroom. This option would not only reduce service bureau charges, but also potentially reduce darkroom and waste disposal costs.

As the company explored this production change, it discovered an important limitation—while it currently produces jobs up to 48 inches in width, the maximum width of dry film is currently 42 inches. Thus, the dry film imaging system could be used for producing only about 85% of the firm's jobs, representing approximately 60% of its annual square footage yield.

ANALYSIS

The company estimates the initial capital investment to be $30,000 for the system, plus $1,300 for training costs. The system is expected to have significant impact on annual operating costs:

Environmental Accounting Snapshot

A SCREEN PRINTER

- **Materials**: The use of silver film and chemicals is expected to decrease by $33,670. However, the annual cost of dry film is expected to be $56,000, resulting in a net increase of $22,330 in materials costs.
- **Labor:** The switch from service bureau to in-house provision of these services will increase annual labor costs by $55,650.
- **Maintenance**: The dry film imaging system requires an annual maintenance contract totaling $2,700.

COST CONSIDERATIONS

	Year One Savings
Waste Management	$ 315
Service Bureau Costs	69,755
Increased Revenue	150,000
Total Savings	**$220,070**
	Year One Costs
Materials	$22,330
Labor	55,650
Maintenance	2,700
Total Costs	**$80,680**

- **Waste Management**: Washwater and fixer disposal costs are expect to decrease slightly, from $3,315 to $3,000, a decrease of $315.
- **Service Bureau Costs**: Decreased use of service bureau assistance will result in a net savings of $69,755, from $91,355 to $21,600.
- **Increased Revenue**: The dry film imaging system will allow the printer to get its jobs to press faster by avoiding the minimum 24-hour turnaround time required when using service bureaus. The company president expects the new capabilities and reduced turnaround time will net the company an additional $150,000 in earnings.

FINANCIAL PARAMETERS The analysis uses a project lifetime of 5 years, cost of capital of 12%, a 3% inflation rate, a net tax rate of 3.6%, and used double declining balance depreciation over 7 years.

FINANCIAL RESULTS Year one project savings are $220,070; year one project costs are $80,680. Thus, year one net savings are $139,390. The 5-year net present value (NPV) of the investment is $495,860. The 5-year internal rate of return (IRR) is 446%. Payback is 0.25 years.

CONTACT Karen Shapiro, Tellus Institute (617) 266-5400.

SOURCE Tellus Institute, *P2/FINANCE for Screen Printers: User's Guide*. 1997.

A SMALL LITHOGRAPHIC PRINTER

BUSINESS DECISION

CAPITAL INVESTMENTS

Is the capital investment in a computerized pre-press system justified?

COMPANY PROFILE

⇒ *Location*: Northern Illinois

⇒ *Size*: 15 employees

⇒ *Annual Revenues*: $1 million

⇒ *Business*: Printing of one- to four-color posters, cards, and booklets.

BUSINESS BENEFITS

Total cost assessment (TCA) yielded a 5-year net present value (NPV) of $187,700 on an initial investment of $49,310. The 5-year internal rate of return (IRR) is 132%. Discounted payback period is 0.82 years. The conventional analysis by the company yielded a 5-year NPV of $58,358, a 5-year IRR of 51%, and payback of 2.14 years.

WHY WAS PROJECT PERFORMED?

This printer provides traditional lithographic printing, including pre-press, printing, and some post-press processing. Prior to purchase of the computerized pre-press system, when the company received jobs on diskette, it needed to send them to a service bureau to produce film for platemaking. This type of work is increasing rapidly. As a result, the company invested in a computer pre-press system that is able to process jobs submitted by customers on disk as well as process incoming camera-ready artwork without intermediate darkroom chemistry.

The company had conducted a conventional financial analysis for the project. The Illinois Waste Management and Research Center funded a TCA of the project as part of a set of case studies of TCA applications in capital budgeting. This study was conducted retrospectively to analyze a recent investment.

PROJECT DESCRIPTION

The printer's clients include community groups, political groups, and non-profit organizations, as well as commercial clients. The printer was operated as a non-profit organization until the mid-1980s, at which time it was incorporated as a for-profit cooperative in order to gain access to financing otherwise unavailable.

At the time the company began considering the investment in a computer pre-press system, about two-thirds of its work came in on disk. Between 1994 and 1996, the costs of using the service bureau to process these jobs had increased from $1,500 to $48,000. The remaining work came in on conventional media (e.g., paper). This material was photographed and the film processed in-house. Developing film produces spent fixer and developer. Some silver recovery took place; however, the Production Manager felt the recovery unit was likely too old to recover much silver. Spent developer was poured down the drain, although the Production Manager was unsure of the regulations.

The computer-based pre-press system is able to directly process jobs that customers submit on disk; camera-ready artwork can be scanned into the system and then processed. As noted above, this system eliminates the need for intermediate films, and produces the platemaking film as part of the system.

A SMALL LITHOGRAPHIC PRINTER

ANALYSIS The quick financial analysis carried out by the company calculated the initial capital cost of the new system as $49,310. Annual savings due to reduced use of the service bureau were estimated at $22,500. This estimate is below the full service bureau costs due to constraints in both the new system's capabilities and in the ability of staff to use the new equipment for more complex jobs. In addition, the company's annual courier charges are estimated to decrease by $1,500.

COST CONSIDERATIONS

	Year One Savings
Service Bureau Costs	$22,500
Courier Charges	1,500
Pre-press Darkroom and Stripping Labor	11,783
Supervision Costs	2,360
Darkroom Chemicals	1,500
External Typesetting	1,710
Increased Revenue	110,000
Total Savings	**$151,353**
	Year One Costs
Pre-press Labor	$19,672
Film	12,600
Total Costs	**$32,272**

The in-depth TCA revealed additional costs and savings. Additional investment costs totaled roughly $2,500, and included the time required by the print shop to solicit and consider bids, contractor work associated with accommodating the new equipment, and initial training costs. Additional annual operating costs revealed by TCA total $32,272, and include new computer pre-press labor ($19,672) and increased film costs ($12,600). Additional annual savings revealed by TCA total $17,353, and include: reduced labor for pre-press darkroom and stripping operations ($11,783); reduced supervision cost ($2,360); reduced use of darkroom chemicals ($1,500); reduced use of external typesetting services ($1,710).

However, the single largest change to a conventional financial analysis was an anticipated increase in annual revenues. Prior to bringing computer pre-press operations in-house, service bureau operations required a 24-hour turnaround. Digital capabilities also enable the company to provide its customers with services they would otherwise acquire elsewhere. Finally, ending reliance on an external service bureau gives the company better overall process control. Together, the company's increased capabilities, faster turnaround, and better process control would lead to an annual incremental revenue of 10%, or $110,000.

FINANCIAL PARAMETERS The analysis uses an inflation rate of 3%, an income tax rate of 37.94%, and a 12% discount rate. A 5-year project life was selected due to fast technology turnover in the industry.

FINANCIAL RESULTS The 5- year net present value (NPV) of the project is $187,700. The 5-year internal rate of return (IRR) is 132%. The discounted payback period is 0.82 years. The conventional analysis by company yielded a 5-year NPV of $58,358, a 5-year IRR of 51%, and a payback period of 2.14 years).

CONTACT Deborah Savage or Edward Reiskin, Tellus Institute (617) 266-5400.

SOURCE Savage, Deborah, et al., *Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois*. For Illinois Waste Management and Research Center, April 1997.

QUEBECOR PRINTING MOUNT MORRIS, INC.

COMPANY PROFILE

⇒ *Location*: Illinois

⇒ *Size*: 650 employees

⇒ *Annual Revenues*: $95 million

⇒ *Business*: Printing of catalogs, magazines, and advertisement inserts

BUSINESS DECISION

CAPITAL INVESTMENTS

Is the capital investment in a continuous membrane filter waste water treatment system to replace the current batch system justified?

BUSINESS BENEFITS

The 10-year net present value (NPV) of the investment is $81,152. The 10-year internal rate of return (IRR) is 17.8%. Payback is 5.66 years. The conventional analysis by company yielded a 10-year NPV of $51,887; a 10-year IRR of 14.7%, and payback of 6.94 years.

WHY WAS PROJECT PERFORMED?

Quebecor Printing Mount Morris, Inc. (QPMMI) provides pre-press, printing, post-press, and distribution services for high-volume customers. QPMMI has direct-to-plate (for web offset) and direct-to-cylinder (for roto-gravure) capabilities. The roto-gravure cylinders are steel, electroplated with copper. They are electro-mechanically engraved and the image area is coated with a five-micron layer of chromium for wear-resistance. Cylinders are reused indefinitely (i.e., they are physical capital), while the scrap copper is sold for recycling.

The gravure cylinder waste streams – about 1 million gallons per year – are contaminated with copper, chromium, and other metals, and are sent to the on-site waste water treatment system. These waste streams are highly acidic and, in addition to high levels of metals, contain some dissolved VOCs and oily waste. The treatment system removes about 99% of the dissolved metals and oily waste, and raises the pH to between 6 and 9. The system consists of a 750-gallon chromium reduction tank, two 5,000-gallon batch settling tanks, an oily waste separation tank, a 1,320-gallon sludge storage tank, and a filter press. The sludge from the settlement tanks, about 12,000 gallons per year, is sent through the filter press to be compressed and dried. A small amount of oil is collected and disposed of as hazardous waste. The solid sludge "cake" is bagged and sent off-site as hazardous waste.

Chemicals for operating this system cost about $11,500 per year. QPMMI's Environmental Coordinator estimates the labor costs involved in water treatment are close to $60,000 per year. The cost of the off-site waste disposal from this operation is over $11,000 per year.

PROJECT DESCRIPTION

The Environmental Coordinator would like to improve QPMMI's waste water treatment system by replacing the current batch system with a continuous membrane filtration system that would precipitate and remove dissolved metals. Waste water from the chromium reduction tank and other gravure cylinder waste water would be transferred to one of the existing 5000 gallon settling tanks, which would be used as a holding tank to equalize the flow into the new membrane filtration system. The new system performs two distinct functions. First, the pH is adjusted and metal hydroxide precipitates are formed, then the metal precipitates are removed using membrane filters. The precipitates would be concentrated and dewatered in the existing filter press. The clean water would be pumped to the second existing settling tank, which would be used as a holding tank so that the outgoing water could be tested before release to the sewer.

The direct capital cost of the new system is $120,000 for the equipment, plus approximately $60,000 for accessory equipment and installation. The new system would use less treatment chemicals than the existing system. Instead of generating sludge requiring treatment as a hazardous waste, the new system would generate a metal concentrate that QPMMI hopes to sell to a metal recycler. In addition, the new system requires much less labor than the old. As a continuous, automatically regulated system, there is little need for oversight.

ANALYSIS

The preliminary financial analysis performed by the company's Environmental Coordinator calculated the initial purchase equipment costs, as specified in vendor quotes, as $119,590. Initial system installation costs were estimated at $58,700. Annual savings from a reduction in direct operating labor was estimated at $24,328, and annual savings from avoided hazardous waste disposal at $10,753. Without considering depreciation, inflation, or a discount rate, the Environmental Coordinator calculated a simple payback of just over five years, considerably above the payback for approved projects. Management did not wish to devote resources to pursuing this project further due to its unlikely approval.

COST CONSIDERATIONS

	Year One Savings
Operating Labor	$24,328
Haz. Waste Disposal	10,753
Waste Water Treatment Chemicals	12,800
Supervision Costs	3,150
Paperwork	1,352
Maintenance	1,352
Total Savings	**$53,735**

The in-depth total cost assessment (TCA) revealed additional costs and savings. Additional investment costs totaled $18,797, and included the time required to plan and design the new system, solicit and consider bids, supervise installation, prepare new environmental operating permits, train operators, and start-up labor time. Additional annual savings revealed by TCA total $18,654, and include: reduced use of waste water treatment chemicals ($12,800); reduced supervisory labor ($3,150); reduced paperwork ($1,352); and reduced maintenance costs ($1,352). No additional annual operating costs were revealed by TCA.

Investigation into recycling the metal concentrate generated by the system found that its value would be sufficient only to cover the costs of removing it from the site. In addition, the reduction in the facility's overall hazardous waste would not be significant enough to change its hazardous waste generator status; therefore, liability reduction was not included.

FINANCIAL PARAMETERS

The analysis uses no inflation, a 37% income tax rate, and an 8½% discount rate.

FINANCIAL RESULTS

The 10-year NPV of the investment is $81,152. The 10-year IRR is 17.8%. Payback is 5.66 years. The conventional analysis by company yielded a 10-year NPV of $51,887; a 10-year IRR of 14.7%, and payback of 6.94 years.

Although the TCA revealed useful information regarding the costs and savings associated with the project, the investment was judged by the company as not sufficiently profitable to receive capital funds. Advances in treatment or metal recycling technology may render this investment profitable in the future.

QUEBECOR PRINTING MOUNT MORRIS, INC.

CONTACT Deborah Savage or Edward Reiskin, Tellus Institute (617) 266-5400.

SOURCE Savage, Deborah, et al., *Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois*. For Illinois Waste Management and Research Center, April 1997.

MANUFACTURER OF MILITARY AND CIVILIAN ELECTRONIC EQUIPMENT

COMPANY PROFILE

⇒ *Location*: Massachusetts

⇒ *Size*: Medium-sized facility

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Products include power supplies for night vision goggles, channel electron multipliers, and high ohmic resistors.

BUSINESS DECISION

CAPITAL INVESTMENTS

What are the savings realized from investment in the following two successive stages of alternatives to a CFC vapor degreaser (1) bench-top degreasers using HCFCs; (2) an ultrasonic cleaning system using terpenes?

BUSINESS BENEFITS

For the bench-top degreaser, the total capital cost of $58,250 resulted in a reduction in annual operating costs of $126,263. The 8-year net present value of this investment was $93,446. For the ultrasonic cleaning system, the total capital cost of $34,034 resulted in a reduction in annual operating costs of $128,895. The 8-year net present value of this investment was $352,814.

WHY WAS PROJECT PERFORMED?

This manufacturer needs to clean solder and flux from printed circuit board assemblies. Due to regulatory and cost considerations, the company sought to identify an alternative to its CFC-based vapor degreaser. The company decided to move to an ultrasonic cleaning system. However, while it was researching the proper chemistry for that system, bench-top degreasers using HCFCs were used. P2 Consulting conducted a comprehensive financial analysis comparing the CFC-based cleaning system with each of these successive stages.

PROJECT DESCRIPTION

Between 1990 and 1992, this medium-sized manufacturer of military and civilian electronic equipment used an average of 14,043 pounds of CFC-113 in its vapor degreaser for cleaning solder and flux from printed circuit board assemblies. Purchases of this CFC cleaning material cost the company $120,348 annually. In 1992, the company began looking for an alternative cleaning process.

Research indicated that the change required a two-stage approach. First, the company purchased an ultrasonic cleaner. However, it was determined that establishing a suitable chemical for the new unit would take approximately 2 years. In the interim, HCFC 141b was brought in as a replacement CFC-113. This required installing customized bench-top vapor degreasers.

ANALYSIS

In addition to the annual CFC purchase cost of $120,348, the manufacturer also faced annual regulatory compliance costs totaling $10,150. At the time of the analysis, the facility was required to file under Massachusetts' Toxic Use Reduction Act (TURA).

The CFC degreaser required a full-time operator, as well as maintenance and utility costs. Other miscellaneous costs associated with the CFC degreaser bring its total annual operating cost to $163,228.

MANUFACTURER OF MILITARY AND CIVILIAN ELECTRONIC EQUIPMENT

COST CONSIDERATIONS

	Annual Savings
CFC Degreaser Costs	$163,228
	Annual Costs
HCFC Degreaser	$36,965

The HCFC degreasers require a capital expenditure of $58,250. This total comprises $48,000 in research and design, $9,810 in in-house equipment fabrications, and $440 in other costs. The chemical costs for this equipment total $37,800, a savings of $82,548 compared to the CFC degreaser. In addition, this option eliminates the need for the full-time operator as well as significant regulatory costs, as TURA reporting is no longer required. In total, the lower operating costs associated with the HCFC degreasers result in an annual savings of the $126,263 compared to the CFC degreaser.

The ultrasonic cleaner requires a capital expenditure of $34,034. The bulk of this cost, $25,525, is due to equipment purchase. The remainder is related to associated research and design costs, and minor changes required to the building. The chemical costs for this equipment total $1,400, a savings of $118,948 compared to the CFC degreaser. In addition, this option also significantly reduces regulatory costs, as TURA reporting is no longer required. The analysis assumed that full-time operator would be required. Annual maintenance costs for the ultrasonic cleaner were somewhat higher than the other options ($2,086) due to the need to regularly replace filters. In total, the lower operating costs associated with the ultrasonic cleaner result in an annual savings of the $128,895 compared to the CFC degreaser.

An additional benefit not quantified is increased productivity due to assembly workers' ability to clean parts at their convenience without waiting.

FINANCIAL PARAMETERS The analysis used straight-line depreciation, a 40% corporate tax rate, and a 10% discount rate.

FINANCIAL RESULTS The 8-year net present value of the two stages was: (1) $93,446 for the HCFC degreaser, and (2) $352,814 for the ultrasonic cleaner.

CONTACT Not provided.

SOURCE Kennedy, Mitchell, "Getting to the Bottom Line: How TCA Shows the Real Cost of Solvent Substitution." *Pollution Prevention Review.* Spring 1994.

PRECISION CIRCUITS, INC.

BUSINESS DECISION

CAPITAL INVESTMENTS

What are the savings realized from the following two investments? (1) New plastic-coated racks used to carry circuit board panels through a series of baths and rinses. The old stainless steel racks had to be cleaned with nitric acid. (2) New waste water treatment process that produces less waste water sludge and fewer waste streams.

COMPANY PROFILE

⇒ *Location*: Lynnwood, WA

⇒ *Size*: 30 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Circuit board manufacturer.

BUSINESS BENEFITS

(1) 5-year Net Present Value is $33,589; 5-year IRR is 66%. Payback is just over one year. A portion of these savings is attributable to quality improvements. (2) This relatively inexpensive change has a 5-year Net Present Value of $62,824. The 5-year IRR is 1,886%. Payback is well under one year.

WHY WAS PROJECT PERFORMED?

Precision Circuits' management policy statement describes the company's commitment to protect the environment as well as the health and safety of its workers and neighbors. Precision Circuits prepared and submitted a Pollution Prevention Plan in 1993 to the Washington Department of the Environment, with a stated goal of reducing its use and generation of hazardous materials and waste by 50%. In 1994, Precision Circuits initiated two changes with positive environmental impacts: (1) they purchased new plastic-coated racks, eliminating nitric acid from the workplace, and (2) a new waste water treatment process was put in place that produces less waste water sludge and fewer waste streams.

The Pacific Northwest Pollution Prevention Resource Center worked with Precision Circuits to demonstrate the use of Total Cost Analysis (TCA) and illustrate its value as an effective decision-making tool for small firms evaluating the costs and benefits of pollution prevention opportunities.

PROJECT DESCRIPTION

(1) Use of New Plastic-Coated Racks

In the manufacture of used circuit boards, the board panels undergo a number of plating and rinsing processes. The boards are carried through these baths on racks. Prior to installing the new plastic-coated racks, the stainless steel racks used required rinsing in solution of nitric acid to clear them of any metals accumulated during the plating process, and thus prevent contamination of the boards and baths during the next plating cycle. The shift to the plastic racks produces three significant benefits: 1) removal of nitric acid from the workplace, 2) elimination of the need to strip the racks, and 3) production of a better product due to the electrical properties of the plastic-coated racks.

(2) Change in Waste Water Treatment Process

A vendor presented Precision Circuits with a new waste water treatment process that results in smaller volume of waste water sludge. Implementing this new process involved relatively minor changes: In addition to replacing one chemical and eliminating another, process steps required minor modification to suit the new treatment chemistry.

PRECISION CIRCUITS, INC.

ANALYSIS

(1) Use of New Plastic-Coated Racks

The cost of switching to the plastic coated racks was estimated by Precision Circuits as $22,522. The primary direct savings to the company came from reduced materials and disposal costs related to eliminating nitric acid. Additional savings came from a reduction in the number of defective boards and increased employee productivity.

COST CONSIDERATIONS

Plastic Coated Racks	Year One Savings
Materials	$5,262
Disposal	$4,445
Quality	$8,660
Employee Productivity	$7,525
Total Savings	**$25,892**
	Year One Costs
Maintenance	$3,674
Total Costs	**$3,674**

(2) Change in Waste Water Treatment Process

The investment associated with implementing the new waste water treatment process was estimated at $900. This small investment yielded significant benefits: Net annual costs for treatment chemicals were reduced by $17,697 (current dollars). In addition, net annual disposal costs were reduced by $10,526 (current dollars). The new process resulted in an annual $150 (current dollars) increase in maintenance costs.

FINANCIAL PARAMETERS

The analysis of the two investments used a cost of capital of 15%, an inflation rate of 10% on disposal costs and 5% on all other items, a tax rate of 40%, and used straight-line depreciation over 5 years.

FINANCIAL RESULTS

(1) Use of New Plastic-Coated Racks

The 5-year net present value of this investment is $33,589. The 5-year internal rate of return is 66%. Straight payback time is just over 1 year. A portion of these savings are attributable to quality improvements.

(2) Change in Waste Water Treatment Process

This relatively inexpensive change has a 5-year net present value of $62,824. The 5-year internal rate of return is 1,886%. Straight payback time is well under 1 year.

CONTACT

Not provided.

SOURCE

Pacific Northwest Pollution Prevention Resource Center, *Analysis of Pollution Prevention and Waste Minimization Opportunities Using Total Cost Assessment: A Case Study in the Electronics Industry*. September 1995.

SAE CIRCUITS

BUSINESS DECISION

CAPITAL INVESTMENTS

Study of replacing the ventilation system in the facility's plating area. Two options for replacement were analyzed: (1) a system with single-speed motors and (2) a system with dual-speed motors.

COMPANY PROFILE

⇒ *Location*: Boulder, CO

⇒ *Size*: 80 employees

⇒ *Annual Revenues*: over $6 million

⇒ *Business*: Manufacturer of double-sided and multi-layer printed circuit boards for supply to fabricators.

BUSINESS BENEFITS

For option (1) the 15 year net present value (NPV) is –$171,782. For option (2) the 15 year NPV is –$143,424. Note that although the NPV of both options is negative, the NPV of option (2) is $28,358 greater than that of option (1).

WHY WAS PROJECT PERFORMED?

SAE Circuits Inc. has been in business since 1972 and is located in Boulder, Colorado. The firm manufactures double-sided and multi-layer printed circuit boards for supply to fabricators. Since beginning as a regional supplier, SAE Circuits has expanded to national sales and is beginning to sell internationally. The firm produced nearly 980,000 boards in 1994 and over 1,300,000 in 1995. SAE Circuits has 80 employees, runs multiple shifts in its 32,000 square foot facility, and has annual sales of over $6 million.

In 1983, SAE Circuits started an active environmental and safety program dedicated to improving productivity and efficiency through pollution prevention and energy efficiency projects and has built on this program by completing such projects each year. SAE Circuits is a partner in the DOE Climate Wise program.

PROJECT DESCRIPTION

SAE Circuits has also participated in the DOE Energy Conservation/Pollution Prevention Assistance for Industry program. A 1995 assessment performed by Colorado State University (CSU) helped SAE Circuits personnel identify a number of pollution prevention and energy efficiency projects that offered increased production capacity through improved processes and employee productivity at lower cost.

The project analyzed here is the replacement of the process ventilation system in the plating area. SAE Circuits' existing ventilation system in the wet process area dated to the initial construction of the facility. Since then, production had increased substantially and ventilation loads exceeded the system's capacity. The system provided 4,500 cubic feet per minute (cfm) of exhaust, while the make-up air system replenished the area with 5,400 cfm of fresh air. This exhaust shortfall caused a positive pressure within the plating area, which at times allowed fumes to migrate throughout the facility. The assessment indicated that ammonium chloride (NH_4Cl) vapor concentrations in the wet process area exceeded regulatory standards by 50% at times. SAE Circuits additionally found that NH_4Cl had begun to cause serious corrosion to the electrical equipment in an adjoining room.

SAE Circuits undertook the installation of a new process ventilation system, consisting of a 16,000 cfm exhaust system and a 14,000 cfm make-up air system, plus a positive pressure system for the adjacent electrical equipment room. The system is designed to be able to

accommodate a central air scrubber to remove pollutants from the exhaust air if emissions standards become more stringent in the future.

The make-up and exhaust fans should be kept running at all times, but during non-production hours the needed capacity is only about 5,000 cfm. Thus designers recommended the purchase of more expensive dual-speed motors to save on electricity and make-up air heating during non-work hours. The dual-speed motors collectively cost $7,200 more than the single-speed motors originally considered.

ANALYSIS The initial investment costs of the two options differ only in the higher cost of the dual-speed motors (plus sales tax). The investment cost for the basic system (option 1) has an equipment cost of $115,395. For the dual-speed system (option 2), the equipment cost is $122,775. For both systems, the labor costs associated with planning, engineering, and installation come to $65,620, and the construction permit adds a cost of $7,800. To keep the existing (inadequate) system would entail an investment of $8,055 to replace the old motors.

Annual operating costs of the basic system (option 1) are $21,577 for utilities to heat the make-up air and operate the motors. The dual-speed motors (option 2) have much lower operating costs during non-work hours, lowering annual operating costs to $15,097. The annual utility operating costs for the existing (inadequate) system are $8,135.

Replacing the existing system would remove a variety of continuing costs in the future. First, the company estimated that further corrosion of electrical and other equipment could cost up to $5,000 per year. Second, as production increased, indoor concentrations of NH_4Cl and other pollutants would increase as well, eventually triggering regulatory action. Third, high indoor pollutant concentrations threatened worker health and would reduce productivity.

FINANCIAL PARAMETERS The analysis uses a discount rate of 11.7 percent, an inflation rate of 3 percent, a net tax rate of 39 percent, and double declining balance depreciation over a seven year period.

FINANCIAL RESULTS The 15 year NPV of option (1) is –$171,782. For option (2), the 15 year NPV is –$143,424. Although the NPV of both options is negative, the company managers decided to make the invest in option (2), which has an NPV $28,358 greater than that of option (1) for an additional investment of $7,200. The primary reason was to allow SAE Circuits to expand production while maintaining compliance.

CONTACT Deborah Savage, Tellus Institute, 617-266-5400.

SOURCE Performance Technologies, Inc., *Process Energy Audit: SAE Circuits Colorado, Inc*. For Public Service Company of Colorado. 1996.

Savage, Deborah, and David Miller, "Workshop on Innovative Financing Results". Originally presented at the "Energy Efficiency & Pollution Prevention" conference sponsored by the Department of Energy. Denver CO, January 23, 1997.

A PAPER COATING MILL

BUSINESS DECISION

CAPITAL INVESTMENTS

Is a capital investment in a less-polluting aqueous coating process financially justified?

COMPANY PROFILE

⇒ *Location*: Northeast US

⇒ *Size*: 900 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Coating, laminating, and converting film, paper, and foil substrates

BUSINESS BENEFITS

For a $900,000 investment, the mill would realize annual operating savings of just under $80,000 with a 6% internal rate of return over 15 years.

WHY WAS PROJECT PERFORMED?

The mill coats paper with both white grade and color grade coatings. The white grades are made with an aqueous-based coating, the color grades contain solvents and some heavy metal-based pigment. The mill had considered converting its color grades to an aqueous/heavy metal-free coating to develop manufacturing flexibility, respond to emerging demand for aqueous/heavy metal-free coated paper, reduce environmental impacts, and improve worker health and safety. After spending more than $200,000 three years earlier to convert to aqueous, the mill halted the project due to a possible plant relocation and quality problems during aqueous trial runs. The conversion was later restarted, but was progressing slowly due to capital and labor constraints, operating cost and wastewater volume concerns, and slow manufacturing rates. The mill's Environmental Manager hoped a better financial analysis of the project would reveal a higher economic value, thereby justifying an accelerated conversion.

PROJECT DESCRIPTION

The first step of the conventional paper coating process is the application of the pigmented base coat, which consists of a number of solvents and heavy metals. The base-coated paper goes through a dryer where most of the solvent evaporates and the remainder of the coating sets on the paper. The vaporized solvent is sent to a solvent recovery system where it is drummed for reuse. The 2,220 drums of still bottoms generated by the mill annually from this process consist of residual solvent, pigments, and other impurities, and are incinerated off site as hazardous waste. Some of the volatile organic compound (VOC) emissions generated both during the coating and recovery processes are ultimately vented to the atmosphere.

The aqueous coating process uses a base coat made from water, acrylic latex resin, and a small amount of ammonia and solvent. Once the full conversion to aqueous is complete, the wash water will be sent to an on-site ultrafiltration system from which the water will be sewered and the solids reused or disposed of as non-hazardous waste. Because the aqueous coating has a shorter shelf life, a certain amount of spoilage is expected. Moreover, since this coating has a relatively high freezing point, a new heating system has to be installed in the storage area. Finally, to overcome drying problems, the base coat dryer must be upgraded.

ANALYSIS

The investment analysis for a conversion to an aqueous/heavy metal-free process uses Total Cost Assessment (TCA), a method to enhance capital budgeting decisions in connection with P2 projects. This TCA includes many costs omitted from the company's original analysis. The cost of new utility systems, for example, was added to the other initial investment costs of equipment, engineering, and training. The company's analysis includes annual operating costs only for labor and some raw materials and waste disposal. The TCA includes annual costs of waste management, utilities, solvent recovery/ultrafiltration, regulatory compliance, and a one-

time future liability savings.

Significant reduction in hazardous waste generation represents a decrease in future liability. The analysis captures this decrease by generating an estimate based on the toxicity and final disposition of hazardous waste. The waste reduction also creates regulatory compliance savings from reduced time spent manifesting and testing hazardous waste. Other considerations identified but not quantified include possible shutdown of the solvent recovery process; enhanced worker safety from reduced flammability, improved industrial hygiene, fewer material handling problems; and the potential for improved product quality.

COST CONSIDERATIONS

	Year One Savings
Waste Management	$ 243,900
Materials	$ 85,000
Labor	$ 11,000
Equipment	$ 35,000
Total Savings	**$ 374,900**
	Year One Costs
Raw Material	$ 27,000
Utilities	$ 87,000
Labor	$ 8,000
Total Costs	**$ 122,000**

FINANCIAL PARAMETERS The analysis uses a 16% cost of capital, a 5% inflation rate, a 40% corporate income tax rate, double declining balance depreciation, and 10- and 15-year project time horizons.

FINANCIAL RESULTS The TCA for the conversion project yields a 15-year net present value (NPV) of negative $395,625, as compared to an NPV of negative $203,643 calculated by the company's analysis. The simple payback for the conversion jumps from 7.6 years in the company's analysis to 11.7 years in the TCA. While the TCA shows the project to be more costly than the previous analysis did, it provides the management with a clearer and more comprehensive picture of both current process costs and the economics of the proposed improvement.

The main savings from the conversion would come from waste management and solvent recovery/ultrafiltration. After the conversion, costs associated with the handling, storage, and transportation of hazardous waste drums as well as waste fees would drop significantly. Operating costs of the ultrafiltration system would be more than offset by the reduced use of the solvent recovery system. However, the conversion would substantially increase utilities costs, including steam, water, electricity, and wastewater generation. The increase in utility costs would be greater than all of the operating cost savings, accounting for the negative NPV.

CONTACT Allen White or Deborah Savage, Tellus Institute (617) 266-5400

SOURCES White, Allen L., Monica Becker, and James Goldstein, *Alternative Approaches to the Financial Evaluation of Industrial Pollution Prevention Investments*. For NJ DEP. November 1991. **And** White, Allen L., Deborah Savage, and Monica Becker, *Revised Executive Summary*. June 1993.

White, Allen L., Monica Becker, and James Goldstein, *Total Cost Assessment: Accelerating Industrial Pollution Prevention Through Innovative Project Financial Analysis: with Applications to the Pulp and Paper Industry*. For US EPA. December 1991. **And** White, Allen, L., Deborah Savage, and Monica Becker, *Revised Executive Summary*. June 1993.

A SPECIALTY PAPER MILL

BUSINESS DECISION

CAPITAL INVESTMENTS

Study of process modifications to a paper manufacturing machinery to allow fiber, filler, and water reuse on 2 machines at all times, even when they are running different grades of paper.

COMPANY PROFILE

⇒ *Location*: United States

⇒ *Size*: One mill of larger corporation. This mill produces approximately 190 tons of paper per year

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Manufacturer of a variety of specialty papers

BUSINESS BENEFITS

The project has total capital costs of $1.47 million. The net annual savings associated with the investment are $911,240. Total cost analysis (TCA) indicates a simple payback period is 1.6 years. The company's conventional analysis yields a payback period of 4.2 years.

WHY WAS PROJECT PERFORMED?

This specialty paper mill is part of a larger corporation that includes pulp, paper, and coating mills. The mill produces a variety of papers, both coated and uncoated. This mill does not manufacture pulp, but instead purchases it, via pipeline, from an neighboring pulp mill. The also does not have a wastewater treatment system. Instead, it pumps its wastewater to the neighboring pulp mill for treatment. Although this wastewater constitutes just over 10 percent of the neighboring mill's wastewater flow, it reportedly has TSS and BOD higher then average. The contract governing wastewater treatment charges to the paper mill was up for renegotiation. The neighboring mill was facing a requirement to reduce it effluent BOD load, and in turn required the paper mill to reduce the BOD content of the wastewater sent to the neighboring mill. This project was driven in part by this requirement.

PROJECT DESCRIPTION

In the manufacture of paper, a mixture of water and residual fiber and filler drains out of the sheet as it passes through the paper making machinery. This liquid, known as white water, is usually captured by a white water collection system dedicated to one paper machine. White water may also be passed through a screening device that separates the white water into its separate streams of clear water and fiber and filler. These components can then be recycled back into the system.

In this mill, two paper machines share a common white water system. One machine also has the screening device installed. If the two machines are producing similar grades of paper, a significant amount of the white water can be recycled. However, when the two machines are producing different grades of paper, the mixed white water is not reusable and must be sewered. Not only does this result in the loss of a large flow of potentially reusable water, fiber, and filler, it also increases the BOD content of the wastewater.

The proposed project is to split the white water systems, so that each machine would have a dedicated system. In addition, a screening device would be installed on the second machine. This would permit fiber, filler, and water reuse on both machines at all times.

A SPECIALTY PAPER MILL

ANALYSIS The project as described has total capital costs of $1.47 million. The company developed a financial analysis that captured those operating costs and savings typically including in their analyses. The more detailed total cost analysis (TCA) included these costs as well as additional costs and savings.

COST CONSIDERATIONS

	Annual Savings
Fiber and Filler	$421,530
H_2O Pumping/Treatment	$112,420
H_2O Heating	$393,400
Wastewater Costs	$122,990
Total Savings	**$1,050,340**

	Annual Costs
Chemicals	$28,700
Electricity	$107,280
Labor	$3,120
Total Costs	**$139,100**

The TCA includes the following annual savings:

- A reduction in fiber and filler loss of 1,200 tons per year ($421,530);
- A reduction in fresh water usage of 1 million gallons per day and a commensurate reduction in fresh water treatment and pumping costs ($112,420);
- A reduction in energy use for fresh water heating ($393,400);
- A reduction in wastewater generation of 1 million gallons per day, resulting in saving $54,750 in wastewater pumping and $68,240 in wastewater treatment.

Annual operating costs are expected to increase in the following areas:

- Chemical flocculating agents used in the screening filter ($28,700);
- Electric costs to operate the new equipment ($107,280);
- Labor required to operate the new equipment ($3,120).

Thus, the net annual savings associated with the $1.47 million investment are $911,240. A number of these costs, totaling $560,570, are omitted from the company's analysis. These savings include those associated with fiber and filler recovery, fresh water heating, and pumping and treatment of both fresh water and wastewater.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS The TCA indicates a 15 year NPV of $2.85 million and a 15 year IRR of 48%. Simple payback period is 1.6 years. The company's initial conventional analysis yields a 15 year NPV of $360,301, a 15 year IRR of 21%, and a payback period of 4.2 years.

CONTACT Deborah Savage, Tellus Institute, 617-266-5400

SOURCES White, A., D. Savage, and A. Dierks, "Environmental Accounting: Principles for the Sustainable Enterprise". Originally presented at the 1995 TAPPI International Environmental Conference, Atlanta Georgia, May 7-10 1995.

White, Allen L., Monica Becker, and James Goldstein, *Total Cost Assessment: Accelerating Industrial Pollution Prevention Through Innovative Project Financial Analysis: with*

Applications to the Pulp and Paper Industry. Prepared for US EPA. December 1991. **Also:** White, A., D. Savage, and M. Becker, *Revised Executive Summary*. June 1993.

White, A., M. Becker, and D. Savage, "Environmentally Smart Accounting Using Total Cost Assessment to Advance Pollution Prevention". *Pollution Prevention Review*. Summer 1993.

NIAGARA MOHAWK POWER COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Analysis of the feasibility of co-firing a fossil-fuel generating plant to produce bioenergy from willow.

BUSINESS BENEFITS

An investment of $2 million will result in annual savings of $1.1 million. Net present value of expected net benefit stream is $793,000.

COMPANY PROFILE

⇒ *Location*: Syracuse, New York

⇒ *Size*: 8,600 Employees

⇒ *Annual Revenues*: $4 billion

⇒ *Business*: Supplier of electricity and natural gas in upstate New York.

WHY WAS PROJECT PERFORMED?

The Niagara Mohawk Power Company (NMPC) is among the leaders in reporting on environmental externalities and using them in the capital investment process. The analysis discussed here is one of several reviewed in a major study of best practices for costing and managing an effective environmental strategy. NMPC makes use of a standard "Benefit Assessment Worksheet" to evaluate capital investment decisions. This snapshot is based on such a worksheet.

PROJECT DESCRIPTION

This particular project is a proposed pilot to assess the feasibility of producing bioenergy by co-firing a fossil-fuel generating plant with coal and willow. NMPC proposes testing this co-firing at its Dunkirk 2 facility in Tully, New York.

ANALYSIS

During 1992, the plant produced 619,120 MWh with 242,914 tons of coal. A total of 9,884 tons of SO_2 was produced as a result of those operations. The proposed project would replace 10 percent of the coal with biomass in the form of willow. The investment required to retrofit the coal plant so it is capable of co-firing biomass is estimated at $200 per kW of capacity. The Dunkirk 2 facility has a capacity of 100 MW, so retrofitting is estimated to cost $2,000,000. In the analysis, the retrofit is expected to occur in 1999.

Because biomass combustion produces very little SO_2, the replacement would result in a ten percent reduction in SO_2, or a 988 ton reduction. At the time of the analysis, a permit to emit one ton of SO_2 was valued at $175. Thus the project would result in annual savings of $172,900 due to reduced SO_2 emissions.

In addition, the National Energy Policy Act of 1992 provides a tax credit of 1.5 cents per kWh for electric power generated in a "closed-cycle-fuels production/utilization system." In this case, 10 percent of the generated power, or 61,912 MWh of energy, is eligible for this credit, for an annual savings of $928,988. This tax credit is due to expire in 2007.

Thus, the total annual benefit is $1,101,588 (= $172,900 + $928,988), and starts in 1999.

Note that a fuel costs are not included in the analysis.

FINANCIAL PARAMETERS

The study uses a discount rate of 10.2 percent, and depreciates the investment in 5 years.

FINANCIAL RESULTS

The net present value (NPV) of the investment is $2,642,650. The analysis further assumes that the benefit has a 30 percent chance of being achieved (the reason for this probability is not

provided). The study applies this factor, reducing the NPV to $792,975.

The Benefit Assessment Worksheet also notes, but does not quantify, a number of additional benefits that may accrue due to the project. For example, it notes that the use of biomass as fuel has essentially no net effect on atmospheric CO_2 levels when the fuel is grown at a sustained level (i.e., the carbon sequestered as new trees are grown to replace those harvested offsets the carbon released through combustion).

CONTACT Not provided.

SOURCE Epstein, Marc J., *Measuring Corporate Environmental Performance: Best Practices for Costing and Managing an Effective Environmental Strategy*. For the Institute of Management Accountants. Chicago: Irwin, 1996. pp. 183-187.

BRISTOL-MYERS SQUIBB COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Will the investment in developing a database system for making innovative, cost-effective solutions to commonly encountered EHS operating challenges accessible company-wide decrease costs (monetary and environmental) and increase productivity?

COMPANY PROFILE

⇒ *Location*: 33 countries worldwide

⇒ *Size*: 51,200 employees

⇒ *Annual Revenues*: $15.1 billion

⇒ *Business*: Diversified worldwide, healthcare company with extensive consumer product lines.

BUSINESS BENEFITS

The system, known as the Best Practices Database, provides a range of benefits: improves productivity; facilitates communication; leverages resources; saves costs and time; enhances EHS performance. Annual savings are estimated at $675,000. The process has recently been expanded to include a total of 20 business functions (e.g., manufacturing, research & development). Since 1993 the Company's Best Practices Sharing database has helped BMS account for over $2.9 million in innovative, cost-saving solutions to commonly encountered operating challenges. The system has been improved over time to enhance its utility.

WHY WAS PROJECT PERFORMED?

A database called "EHS Best Practices" was developed to identify, summarize, and share environmental, health, and safety (EHS) operating solutions among Bristol-Myers Squibb (BMS) facilities worldwide. The database tracks company-wide EHS activities with regard to BMS business mission, goals, and activities to support the company's 16 EHS Codes of Practice (based on the 16 International Chamber of Commerce Principles for Sustainable Development), and provides financial costs and benefits data. Specifically tailored data for individual business groups and divisions are also provided.

This system drives improvement in productivity by leveraging resources and ideas company-wide. It also supports timely, consistent, cost-effective regulatory compliance.

PROJECT DESCRIPTION

A "Best Practice" is a unique way to solve a problem or address an issue that may be faced by other BMS facilities. Best Practices are identified during routine company-wide EHS management systems audits or are self-nominated by facilities. Practices are reviewed for completeness and transferability prior to final posting in the database.

The BMS Best Practices database is designed to cost-effectively share solutions throughout the company among employees supporting core manufacturing and other business functions of the Company. Best Practices for overcoming common business challenges can be researched or entered by virtually any BMS employee with a computer. There are currently 214 Best Practices available which address 20 business functional areas.

For example, one such Best Practice describes the recycling of solvents used in high performance liquid chromatography (HPLC), a standard laboratory analysis technique. In BMS's New Brunswick, NJ, laboratories, installation of the solvent recycling system cost about $12,500 and resulted in savings of $35,000.

Documents in the database provide users with an overview of each practice, and names individuals to contact for more details. The goal is to facilitate direct transfer of technology among individuals involved with implementing solutions to commonly faced problems.

ANALYSIS The initial cost of implementing the Best Practices database was $40,000. This figure accounted for the development of the Best Practices database structure by an outside consulting firm. An additional $20,000 was invested in improving and expanding Best Practices. This further development was performed internally. Based on $2.9 million in savings currently available for sharing by the database, and 214 Best Practices in final form, the average benefit to the company per practice is approximately $13,500. BMS estimates that annually a minimum of 25 posted Best Practices will be used by at least 2 facilities. This estimate implies an annual savings to BMS of:

(25 Best Practices/year) ∗ (2 facilities via sharing) ∗ ($13,500 saving per Best Practice) = $675,000/year.

BMS believes this figure to be conservative. Since 1993 the Best Practices database has reflected only EHS-related solutions. As other business functions begin using Best Practices, BMS anticipates even greater business benefit.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS By sharing cost saving and cost avoiding solutions among several sites, the benefits achieved by implementing a Best Practice can be multiplied many times over. BMS estimates the system results in an annual savings to the company of at least $675,000.

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SOURCE For further information please visit the BMS website at: http://www.bms.com

BRISTOL-MYERS SQUIBB COMPANY

BUSINESS DECISION

CAPITAL INVESTMENTS

Does consideration of environmental, health, and safety (EHS) impacts at each step of a product's life cycle enhance both environmental and monetary savings?

COMPANY PROFILE

⇒ *Location*: 33 countries worldwide

⇒ *Size*: 51,200 employees

⇒ *Annual Revenues*: $15.1 billion

⇒ *Business*: Diversified worldwide, healthcare company with extensive consumer product lines.

BUSINESS BENEFITS

Analyzing every step of a product's life cycle has allowed Bristol-Myers Squibb to identify and reduce negative EHS impacts at each stage. The company estimates that each product life cycle review performed costs about $25,000 and results in cost savings averaging $340,000.

WHY WAS PROJECT PERFORMED?

Bristol-Myers Squibb's (BMS) business strategy is one of EHS leadership going beyond compliance. This strategy is characterized by a strong management system coupled with measurable standards. In 1991, BMS established a company-wide commitment to leadership in environmental, health, and safety (EHS) management. As part of this commitment, product life cycle (PLC) management was undertaken. PLC review has the goal of minimizing the environmental impacts of BMS products by evaluating opportunities for improvement at each stage of the product's life cycle, including design, manufacturing, packaging, distribution, use, and ultimate disposal. Bristol-Myers Squibb has conducted PLC reviews of all its major product lines.

Also in 1991, BMS endorsed the International Chamber of Commerce (ICC) Business Charter for Sustainable Development, a set of 16 principles guiding EHS management of businesses. The business charter calls on industry to "develop and provide products or services that have no undue environmental impact and are safe in their intended use; that are efficient in their consumption of energy and natural resources; and that can be recycled, reused or disposed of safely." PLC assessment is a means of meeting EHS leadership goals as well as complying with ICC principles.

PROJECT DESCRIPTION

The concept of product life cycle review is fairly simple: define each stage of the product's life and conduct an in-depth analysis of impacts at each stage. The stages identified by BMS are: research and product development; marketing; packaging; sales, distribution, and transportation; consumer use; and final disposition. BMS forms a PLC review team that incorporates members with expertise at each stage of the product's life cycle.

PLC reviews comprised several steps typically spanning four to six monthly meetings of the project team. Over the course of the meetings, the team is educated about the company's EHS goals, and the role of PLC reviews in meeting those goals. PLC team members identify and evaluate EHS impacts and potential product and process improvements using an iterative process. Team members review supporting document to assist them in identifying EHS issues relevant to their segment of the product life cycle, and in identifying potential opportunities for improving the product's EHS profile. Estimates are made of material and energy savings, avoided pollution, and costs and savings incurred by each opportunity. Team members then present their findings to the group. Ensuing discussions provide cross-fertilization of ideas and

feedback, generating new ideas and identifying additional information and data. Each option is evaluated using three criteria: (1) ease or difficulty of implementing; (2) costs of implementing; and (3) benefits of implementing the option (e.g., reduced costs, increased productivity). Based upon these criteria, the team collectively decides which improvements to recommend to management.

Time and resources required for implementing an improvement are important drivers for determining ease or difficulty of implementing an option. Anticipated costs and benefits of an improvement option include one-time capital costs and annual operating costs, including those that may arise from production effects (e.g., decreased cycle time, increased performance); changes in energy and raw material requirements; and changes in amounts and types of releases to the environment (including the work environment). Only the easily quantifiable raw material cost savings are monetized, whereas the decrease in process time is estimated, but not monetized. Energy savings are neither quantified nor monetized. Health and safety improvements share equal emphasis with monetary improvements. Evaluated improvements are prioritized as either high, medium, or low. The improvements deemed high priority are then recommended for approval by management. These options are identified and evaluated in the final report at the end of the PLC review.

ANALYSIS The Product Life Cycle review projects have proven to be a tremendous success. The average implementation cost of each product life cycle innovation is approximately $25,000/review. The PLC reviews which have been completed resulted in cost savings opportunities averaging $340,000 per review, for a net savings of about $315,000 per review. Total potential savings for all reviews exceeds $7 million.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS As noted, the net savings per PLC review is approximately $315,000. In addition, BMS has completed its corporate goal of completing Product Life Cycle reviews of all product lines. The company believes that the financial and business communities realize that BMS' commitment toward the environment and to the health and safety of its employees has an impact on long-term performance.

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SOURCE For further information please visit the BMS website at: http://www.bms.com

TIZ'S DOOR SALES, INC.

BUSINESS DECISION

CAPITAL INVESTMENTS

Is a capital investment in a less-polluting coating process financially justified?

BUSINESS BENEFITS

For an investment under $190,000, Tiz's Door Sales (Tiz) would see annual operating savings ranging from $137,000 to $180,000 in the first five years.

COMPANY PROFILE

⇒ *Location*: Everett, WA

⇒ *Size*: 50 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Manufacturer of wood doors and window trim

WHY WAS PROJECT PERFORMED?

Tiz, established in 1966, has always used petroleum-based paints in its processes to coat wood products. Tiz was considering an ultraviolet (UV) coating process to replace its conventional petroleum-based process. The UV process – whereby wood lacquer is cured by UV light rather than by air drying – would have lower operating costs and would generate less pollution, but would require a large initial capital investment.

The company and the Pacific Northwest Pollution Prevention Resource Center jointly conducted the study to illustrate the use of a comprehensive financial analysis to evaluate the feasibility of converting to the UV process. The larger purpose of the study was to promote pollution prevention (P2) in the wood products manufacturing industry.

PROJECT DESCRIPTION

Tiz currently coats wood products by applying a coat of color stain and two coats of petroleum-based lacquer. After the first lacquer coat, the wood pieces sit for 10 minutes to dry, and after the second, they sit for 20 minutes. The lacquer costs $10 per gallon and loses 70% of its volume to evaporation during the coating process, which generates air emissions and exposes workers to vapors. The UV investment would place a curing oven at the end of the coating line. Immediately after coating, the wood pieces would enter the oven where they would cure in seven seconds (as opposed to 10 or 20 minutes). The UV-curable lacquer costs $25 per gallon, but will lose virtually none of its volume because it does not evaporate during the coating process. Therefore, it would significantly reduce the air emissions from the process. To accommodate the new lacquer, new distribution lines would have to be installed to carry the lacquer from the storage area to the process line, and the spray-gun nozzles would have to be modified slightly.

Another benefit of the UV-cured lacquer is that it does not discolor (yellow) when exposed to sunlight. The yellowing process occurs over an extended period of time, but can have a direct effect on Tiz's operations; Tiz had recently paid a settlement to a customer because of yellowing problems. Eliminating this problem would not only eventually eliminate future settlements, it would also improve the quality of Tiz's products, and thus represent a competitive advantage. Because the effect of eliminating yellowing was difficult to quantify, it was not included in the financial analysis, but it was weighed as an important less tangible, qualitative factor. The benefit to employees who would no longer be exposed to potentially hazardous vapors was similarly considered to be important, but not quantified.

ANALYSIS

The investment in a conversion to a UV process was evaluated using Total Cost Assessment (TCA), a method to enhance capital budgeting decisions in connection with P2 projects. The

initial investment costs include not only equipment, materials, and installation, but also utility connections, site preparation, and savings in permitting costs and insurance. The savings would result from reduced toxic emissions that would eliminate the need for an air permit and would lower explosion risk.

COST CONSIDERATIONS

	Year One Savings
Permits/Insurance	$ 4,300
Materials	$ 124,000
Labor	$ 44,800
Equipment	$ 3,300
Tax	$ 11,900
Total Savings	**$ 188,300**
	Year One Costs
Utilities	$ 3,000
Rework	$ 48,000
Total Costs	**$ 51,000**

Since the conversion would not affect many of Tiz's operating costs, the analysis focused only on those costs that would change as a result of the investment. These costs included utilities and rework, and savings in lacquer costs, labor, and equipment replacement. In addition, the tax savings from the equipment depreciation were included.

FINANCIAL PARAMETERS The analysis used a 6% discount rate.

FINANCIAL RESULTS Different scenarios reflect different potential cash flow streams. Each allowed for different equipment costs, insurance savings, rework costs (with the new system, pieces that are coated improperly cannot be reworked and must be scrapped), and depreciation tax savings. Each scenario was run for both a five-year and a ten-year project life. Across all scenarios, the net present values (NPVs) ranged from $240,420 to $1,817,834 for which the investment would pay for itself, on a discounted basis, in one to two years.

A number of critical assumptions underlying the analysis were individually tested to determine their effect on profitability. These included the expected cost of the new lacquer, the cost of rework, the depreciation method, and the discount rate. Of these, the expected cost of the UV-curable lacquer was the most significant driver, reducing the NPV in one scenario from $450,000 to $100,000 when the lacquer cost rose from $25 per gallon to $30.

INSTITUTIONAL CHANGE This project has had a substantial impact on the way Tiz's Door Sales analyzes capital investments. The company now routinely includes on their cost list indirect cost items, such as liability, "green" product markets, and avoided raw material costs. They are currently investigating replacing their diesel delivery vehicles with alternative-fueled vehicles, and are using ECA to evaluate options for replacing high-volume low-pressure (HVLP) spray guns.

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Greg Tisdel, Tiz's Door Sales, Inc. (425) 621-8369

SOURCE Pacific Northwest Pollution Prevention Resource Center, *Economic Analysis: Converting from Petroleum-Based to Ultraviolet-Light Cured Coating System for Medium-Size Wood Products Manufacturers*. 1994.

AMOCO OIL COMPANY

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Facility-wide study of oil refinery to gain insight into environmental cost accounting in a highly integrated oil refinery.

COMPANY PROFILE

⇒ *Location*: Yorktown, Virginia

⇒ *Size*: 53,000 barrels per day

⇒ *Annual Revenues*: Corporation as whole—$10.8 billion worldwide

⇒ *Business*: Integrated petroleum/chemical company

BUSINESS BENEFITS

Analysis of environmental costs indicated such costs were over six times higher than Amoco EHS staff provided in an initial, informal estimate. This meant that returns on investments to reduce environmental costs were consistently underestimated. Environmental accounting techniques allow a more accurate understanding of the business benefits of such investments.

WHY WAS PROJECT PERFORMED?

The Amoco Corporation is a worldwide integrated petroleum and chemical company. Amoco Oil Company is one of three major operating companies of the corporation (the others are Amoco Production Company and Amoco Chemical Company). At the time of this study, Amoco Oil operated five refineries in the United States, with a total capacity of just under 1 million barrels per day.

This case study focused on a single refinery, in Yorktown, VA. Although this is a small refinery (53,000 barrels/day) relative to Amoco's larger facilities (over 400,000 barrels/day), it is nonetheless considered a "complex" refinery. In addition, the Yorktown facility makes a rich subject for this case study because it was the setting for the unprecedented collaborative Amoco/Environmental Protection Agency. This project quantified air emissions, water discharges, and other wastes generated at the facility. Moreover, it identified a range of options to reduce or prevent those releases, some of which appeared more cost-effective that those required by existing rules.

As a part of a major study of corporate environmental accounting, the World Resources Institute built on the Amoco/EPA study to evaluate the environmental costs associated with the complex, highly integrated refinery.

PROJECT DESCRIPTION

Crude oil and natural gas provide a raw material of diverse hydrocarbons. The refining process uses both thermal and chemical processes to separate this mixture into "fractions" of more homogenous mixtures. Separation typically occurs according to the boiling points of the components, with lighter fractions (including those used to make gasoline) separated at lower temperatures and heavier fractions (such as those used to make jet fuels, kerosene, and fuel oil) separated at higher temperatures. Additional products can be recovered from the residuals using a wide variety of techniques, including the use of catalysts.

Determining the mix of outputs to be produced by a given refinery involves an extremely complex decision-making process that uses as inputs market demands, product margins, transportation costs, refinery technology, and price and availability of crude. In addition, refinery operations are highly interrelated, with the input to one operation dependent on the output of one or more previous operations.

AMOCO OIL COMPANY

This degree of integration posed obstacles to early attempts to trace environmental costs to products, raw materials, capital project decisions, or specific units or processes. None of these attempts were satisfactory, due either to difficulties associated with the integrated nature of operations, or failure to capture a sufficient fraction of refinery environmental costs.

The study instead looked at environmental costs on a refinery-wide basis. The approach entailed analyzing accounts contained in the facility's general financial system and determining what portion, if any, of each cost item was environmental. This information was supplemented by other sources such as the company's Maintenance Management System.

COST CONSIDERATIONS

Environmental Cost Category	Percentage of 1993 Non-Crude Operating Costs
Waste Treatment	4.9
Maintenance	3.3
Product Requirements	2.7
Depreciation	2.5
Administration, Compliance	2.4
Sulphur Recovery	1.1
Waste Disposal	0.7
Non-Recurring Costs	4.0
Total	**21.9**

ANALYSIS At most refineries, operating costs are dominated by crude oil. Thus, even small fluctuations in the price of crude can overshadow other operating costs of the refinery. As a result, it is the custom at the refinery level to track "non-crude operating costs," excluding the costs of feedstock.

The analysis estimates that total environmentally related costs are 21.9 percent of total non-crude operating costs. This total focuses primarily on capital, operating, and maintenance costs, and excludes contingent liability costs. If these costs were added, the total could be higher. Remediation expenses are recorded as "non-recurring costs" .

Note that maintenance costs, estimated at 3.3 percent of non-crude operating costs, far exceed the sum of waste disposal, fees, fines, and penalties. 2.7 percent of non-crude operating costs is attributed to complying with environmental regulations associated with product specifications.

At the outset of the project, prior to conducting the analysis, environmental personnel estimated informally estimated environmentally related costs at only three percent of total non-crude operating costs. The magnitude of this difference, as well as the magnitude of the costs, indicates the value of identifying and tracking environmental costs.

FINANCIAL PARAMETERS Not applicable.

FINANCIAL RESULTS Not applicable.

CONTACT Not provided.

SOURCE Ditz, Daryl, Janet Ranganathan, and R. Darryl Banks, *Green Ledgers: Case Studies in Corporate Environmental Accounting*. World Resources Institute, May 1995.

CIBA-GEIGY (NOVARTIS)

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Study of the environmental costs associated with the production of a single chemical additive used to increase stability of plastics.

BUSINESS BENEFITS

The study reveals that, with minor changes, the Ciba-Geigy accounting system could make better use of information already reported to provide better environmental cost information for managerial decision making.

COMPANY PROFILE

⇒ *Location*: 60 countries

⇒ *Size*: 92,000 employees

⇒ *Annual Revenues*: Not provided

⇒ *Business*: Manufacturer of diversified chemical products.

WHY WAS PROJECT PERFORMED?

Ciba-Geigy (now merged with Sandoz as Novartis) is an internationally diversified company headquartered in Basel, Switzerland operating with 92,000 employees in 60 countries. Ciba is a major producer of pharmaceuticals, specialty chemicals and agricultural products, diagnostic products, plant protection and animal health products, seeds, dyes, chemicals, additives, pigments, and polymers. The company's worldwide operations range from mature, low-growth products in the commodity chemical divisions to higher growth specialty or niche chemicals, including value-added special formulations to meet individual customers' needs, to advanced technology-based high-growth pharmaceuticals. The company is vertically integrated, producing may of its own intermediate chemicals.

Ciba has a stated goal of reducing energy consumption and waste in all forms. It has committed to develop new processes for reclamation, reprocessing, and recycling emissions and effluents. It also has a goal to remove solvents and other highly reactive compounds from production processes as soon as possible.

As a part of a major study of corporate environmental accounting, the World Resources Institute evaluated Ciba-Geigy's environmental management accounting practices.

PROJECT DESCRIPTION

As a sample exercise in environmental accounting, the researchers carried out an analysis of the environmental costs associated with manufacturing a single chemical additive, given the fictitious name *Stabilan*, that is used to increase the shelf life and stability of a wide range of products. *Stabilan* is one of several substances produced by Ciba's Additives Division. The product is manufactured on a batch basis on any of several flexible processing lines that are also used to produced other additives.

Stabilan is used in products that come in contact with food. As such, it meets Food and Drug Administration guidelines for comestible products. However, the complex manufacturing process for *Stabilan* requires the use of three compounds that have significant environmental, health, or safety implications. One, a highly reactive substance, is a key building block in production of the intermediate; the other two, both solvents, generate volatile organic compound (VOC) emissions. In addition, VOC residues in waste water effluents result from production and flushing of lines for product changeovers. This effluent is processed at an on-site wastewater treatment facility.

Information on environment-driven activities and costs associated with was gathered from discussions with Additive Division employees as well as with service providers to the Division.

ANALYSIS Cost components are assigned to one of 15 categories (e.g., solvents, packaging materials, materials handling, overhead, steam, etc.), and identified as being one of four types of costs: direct variable; indirect variable; indirect fixed; or, historical. Raw material costs are excluded from the analysis to safeguard potentially confidential data.

Two of these cost components—solvent recovery and wastewater treatment charges—are flagged as being fully attributable as environmental costs. Together they total 15 percent of the of the total manufacturing costs of *Stabilan*, excluding raw material costs.

Ciba's accounting system does not permit an accurate estimation of the upper and lower bound for the environmental portion of a majority of cost elements. Thus, in order to provide a conservative analysis, the remaining cost components are assigned an "estimated environmental portion," which in most cases is a range representing theoretical limits (i.e., 0 to 100 percent). Based on this analysis, environmental costs are estimated to range between 19 and 72 percent of the total manufacturing costs of *Stabilan*, excluding raw material costs.

Among the recommendations of the researchers is that Ciba managers consider further analysis and refinement of the bounds of the environmental costs range assigned to the various components. Availability of improved estimates would enhance the quality of environmental information available to managers.

The overall recommendation of the researchers is that Ciba explore the possibility of making minor changes to its current information system to enhance its ability to provide relevant information to support decisions. Ciba already has a comprehensive, fully integrated general ledger system in use at all sites worldwide. Currently, however, the system aggregates many costs into overhead categories prior to reporting them out. The researchers note that in many cases the input of an additional code at the time of data entry is all that is required to achieve this enhancement.

FINANCIAL PARAMETERS Not applicable.

FINANCIAL RESULTS Not published in study at request of Ciba-Geigy.

CONTACT Not provided.

SOURCE Ditz, Daryl, Janet Ranganathan, and R. Darryl Banks, *Green Ledgers: Case Studies in Corporate Environmental Accounting*. World Resources Institute, May 1995.

A RESINS MANUFACTURER

COMPANY PROFILE

⇒ *Location*: Midwest US

⇒ *Size*: 220 employees

⇒ *Annual Revenues*: $300,000,000

⇒ *Business*: Manufacturer of resin products used in paints, coatings, and reinforced fiberglass

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Does improved estimation of operating costs enhance the firm's ability to identify pollution prevention opportunities?

BUSINESS BENEFITS

This manufacturer found that its product costing, in one case, significantly misrepresented the actual cost of producing the product.

WHY WAS PROJECT PERFORMED?

In accord with the company's commitment to an aggressive pollution prevention (P2) program, the facility in this study joined with the Illinois Waste Management Research Center to more rigorously cost one of its products, Resin A. The exercise entailed a technical evaluation of the manufacturing process and a financial analysis of the product line to determine the cost of waste. The purpose was to improve the facility's understanding of the process to identify and later implement P2 opportunities.

The project sought to identify opportunities to improve Resin A's manufacturing process through capital purchases or optimization of its operating parameters. A longer-term objective was to improve costing systems to facilitate P2 throughout the company. Tellus Institute worked with the company to characterize the existing allocation system and suggest ideas for improvement. In addition to looking at the company's method of allocation, the analysis evaluated the effect of enhanced allocation methods on product costs.

PROJECT DESCRIPTION

Resin A is part of the alkyd resins family of products, one of four the facility produces. The resin products are processed in batch reactor vessels where the raw materials are heated. A solvent solution is added to the reacted resin mixture to change its physical properties. The process generates air emissions and various streams of hazardous and non-hazardous waste. Unlike most of the resin products, Resin A undergoes a final filtering process to remove an unwanted by-product; a process step that generates additional waste. It is because Resin A requires this extra step that it was selected as the focus for the facility's study.

The first stage of the project was to calculate the cost of manufacturing Resin A based on the facility's existing costing methods. This stage would serve as the baseline against which recommended enhancements could be compared. The subsequent stage evaluated alternative methods of costing to more accurately reflect the cost of the product. Rather than develop a new method of process costing, the evaluation began with the existing system and built upon it. Two separate analyses, a surcharge analysis and an allocation analysis, were run to respectively evaluate the impact of (1) the facility's surcharge system whereby cost adjustments are applied to processes thought to have unusually high costs, and (2) the allocation system used to assign indirect costs.

ANALYSIS

The facility organizes cost data into waste cost and conversion cost. The waste cost includes disposal and transportation fees for off-site disposal and utility costs for on-site treatment. A waste tracking system determines the waste cost for the facility organized by waste type. The conversion cost comprises indirect operating costs that are assigned to individual products.

A RESINS MANUFACTURER

Conversion costs are allocated as direct costs (labor, utilities, equipment depreciation) on the basis of reaction time, as overhead (waste management, administration) on the basis of number of batches, or as fixed costs (safety materials, shipping labor) on the basis of product volume. A surcharge is added on top of these costs when a product requires extra steps, such as filtration, in its processing. Using this method, the facility determines the cost of producing Resin A. Despite Resin A's extra filtration step, it did not receive a surcharge.

COST CONSIDERATIONS

	Reallocation Savings
Labor	$ 125,000
Total Savings	**$ 125,000**
	Reallocation Costs
Conversion Cost	$ 26,000
Waste	$ 22,000
Total Costs	**$ 48,000**

The process of manufacturing Resin A was reevaluated to identify any surcharges that might be warranted. The filtration step at the end of the process did represent an extra cost that was not being charged back to the process. This comprised the cost of the filtration labor, filter paper and powder, and filtration waste disposal. The allocation of costs was also reevaluated for three of the process's major costs; operating labor, waste disposal, and environmental management labor. As an alternative method, operating labor was estimated based on actual labor spent on the process rather than an allocation based on the product's reaction time. Similarly, waste disposal costs were estimated based on actual waste generated versus an allocation based on the number of batches produced. Finally, environmental management labor was estimated by determining the portion of the environmental engineer's time spent on the Resin A process rather than by allocation on a product volume basis.

FINANCIAL PARAMETERS

Not applicable.

FINANCIAL RESULTS

The facility's conversion cost for Resin A is $257,000 for the four million pounds of product manufactured and the waste cost assigned is just under $30,000. The surcharge analysis calculated a filtration step cost of over $650 per batch, which effectively increases Resin A's conversion cost by 10%. Omission of the surcharge therefore put the product's assigned cost significantly below its actual cost.

The allocation analysis found the actual cost of operating labor to manufacture Resin A to be close to $20,000 compared to the facility's allocation of $145,000. Because the process to manufacture Resin A generates substantial hazardous waste, the bottom-up estimate of waste disposal showed actual costs to be $52,000 compared the facility's estimate of $30,000. The facility's focus on waste minimization meant that the environmental engineer spent proportionally more of her time on the Resin A line because the facility had targeted it for improvements. As a result, almost 18% of her time was actually spent on the process as opposed to the 4% assigned via the facility's allocation system. Based on the information uncovered by this project, management can reevaluate the cost of Resin A and better asses the economic value of reducing the product's environmental impacts.

INSTITUTIONAL CHANGE

This project has a modest effect on the way this company carries out internal financial analysis. They have expanded their cost list in cost accounting activities to include avoided raw material

costs. Otherwise, the company has not changed its practices.

CONTACT Deborah Savage, Tellus Institute (617) 266-5400

SOURCE Savage, Deborah, et al., *Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois*. For Illinois Waste Management and Research Center, April 1997.

S.C. JOHNSON WAX

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Study of the environmental costs associated with one household pesticide product.

COMPANY PROFILE

⇒ *Location*: Facilities in 49 countries

⇒ *Size*: 13,000 employees

⇒ *Annual Revenues*: Not reported

⇒ *Business*: Manufacturer of chemical specialty products for home care, insect control, and personal care.

BUSINESS BENEFITS

Analysis using environmental accounting techniques indicated environmentally related costs were actually about 50 percent greater than indicated by the current accounting system. This meant that returns on investments to reduce environmental costs were consistently underestimated. Environmental accounting techniques allow a more accurate understanding of the business benefits of such investments.

WHY WAS PROJECT PERFORMED?

S. C. Johnson Wax (SCJ) is a large, privately held corporation. The company is one of the world's leading providers of chemical specialty products for the home and workplace. The corporations has several divisions. This case study focuses on production by the Insect Control Business. This division faces a range of environmental challenges arising from product registration, marketing, and post-consumer product management (such as recycling of aerosol cans). Proliferating state regulations on pesticide labeling and use represent a major issue for the company. Regulation affects lead times for registering products and developing formulations, which in turn affects the incentive to develop new active ingredients.

As a part of a major study of corporate environmental accounting, the World Resources Institute evaluated SCJ's environmental management accounting practices. The case described below is a part of this study.

PROJECT DESCRIPTION

As a sample exercise in environmental accounting, the researchers carried out an analysis of the environmental costs associated with production and sales of a single household pesticide product manufactured by SCJ's Waxdale, Wisconsin, manufacturing facility. The specific product considered is one of several aerosols produced by the facility, and the aerosol production lines are only one part of the manufacturing facility.

ANALYSIS

Department personnel were interviewed and asked to conduct self-audits of their time in order to estimate the portion of staff time spent in environmental activities. Documents such as departmental expense statements and manufacturing overhead studies were also reviewed to gather information on other costs. Costs related to Sales, R&D, and Administrative Management personnel were not estimated in the analysis.

This analysis reveals that waste processing and other non-personnel-related environmental expenses associated with manufacturing are relatively low, totaling only 0.25 percent of manufacturing costs-of-sales. The analysis also reveals that manufacturing personnel costs associated with environmental initiatives total 2.7 percent of operating expenses. Both of these costs are captured by the corporation's current accounting system.

However, the analysis indicates several additional environmental related costs are not captured by the accounting system. These include the registration fees and mill taxes, environmental R&D projects, allocated Environmental and Safety Actions expenses, and directly identifiable legal expenses. These costs total only 0.04 percent of manufacturing costs-of-sales; however the registration fees and mill taxes alone comprise fully 17 percent of marketing administration. In addition, about 21 percent of marketing administration personnel expenses are associated with environmental concerns, totaling 1.6 percent of operating expenses. Together, these costs *not* captured by the accounting system as environmentally related total over 50 percent of the costs that *are* captured.

This result indicates that in at least some cases, environmental costs resulting from manufacturing operations are not captured by the current accounting system. If the results of the analysis of this single chemical are typical of the corporation as a whole, it may indicate that the current accounting system undervalues investments in environmental improvements. That is, if the result for this one product are typical, the savings that would accrue from environmental improvements would be at least 50 percent greater than the current system indicates.

FINANCIAL PARAMETERS Not applicable.

FINANCIAL RESULTS Not applicable.

CONTACT Not provided.

SOURCE Ditz, Daryl, Janet Ranganathan, and R. Darryl Banks, *Green Ledgers: Case Studies in Corporate Environmental Accounting*. World Resources Institute, May 1995.

A FORESTRY COMPANY

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Study of three forestry options: (1) business as usual (full compliance with current government guidelines); (2) full compliance plus selective response to public concerns over sustainable development; (3) full implementation of sustainable development (i.e., preserve forest's natural growth cycle).

COMPANY PROFILE

⇒ *Location*: Ontario, Canada

⇒ *Size*: 6,500 sq. miles of forest

⇒ *Annual Revenues*: Not provided

⇒ *Business*: Lumber & pulp mill operations.

BUSINESS BENEFITS

The study provides an initial attempt to develop accounting techniques that address issues of sustainability. As such, it provides insight into questions that arise with increasing frequency as corporations and society become increasingly concerned with non-commercial matters such as preservation of the environment, employment equity, and worker safety.

WHY WAS PROJECT PERFORMED?

The author of this study is a principal in the Canadian Office of the Auditor General, and is a chartered accountant. He views our society as entering a new epoch of accounting for wealth, in which business is becoming increasingly accountable for a growing range of intangibles. There is thus a need for accountants to make the necessary conceptual adjustments and develop the tools needed to account for these new business realities.

In part due to earlier work related to the damage to natural capital in the *Exxon Valdez* oil spill, the author was invited by the UN's Center on Transnational Corporations to conduct a pilot project on accounting for sustainable development. The project had five goals: 1) use data from operations of a real resource company; 2) determine costs of implementing sustainable development; 3) determine the company's "sustainable income" (i.e., reported bottom line income adjusted to reflect the potential cost of damage to the company's natural capital); 4) expand the traditional definition of assets to encompass the overall environment upon which the company depends to remain in business; 5) create a reporting package to summarize information on the company's environmental stewardship.

Specifically, the author chose to analyze a large forestry company which leases 6,500 square miles of forest land from the province of Ontario. Cut timber supplies the company's sawmill and pulp mill. The CEO of the company was excited at the opportunity to participate in the study, as traditional accounting methods failed to provide him with information he needed to engage fully in the debate regarding the environmental issues surrounding forestry.

PROJECT DESCRIPTION

Due to the considerable ambiguity surrounding the concept of sustainable development, and the formidable information requirements facing even a limited analysis, the project studied three forestry options: (1) business as usual—full compliance with current government guidelines without implementing sustainable development; (2) full compliance plus selective response to public concerns over sustainable development; (3) full implementation of sustainable development (i.e., harvest quantity and technology used would be determined so as to preserve the forest's natural growth cycle).

A FORESTRY COMPANY

ANALYSIS The analysis required making a large number of decisions regarding the boundaries and scope of the study. The researcher first decided that the accounting entity would be the traditional assets plus the 6,500 square miles of natural capital on which it depends. It was decided that including the entire boreal forest as context was too ambitious for a pilot project.

To analyze costs of the three forestry management options outlined above required additional decisions. First, it was decided to use the abatement cost approach—using the estimated the cost of fixing an environmental problem as a proxy for the cost of damage. This approach was chosen because it is much simpler than the damage costing approach—where actual cost of damage to the environmental and human health are estimated directly. The analysis indicates that Option 2 would increase annual operating costs by $8.8 million; Option 3 would require a $22.3 million increase. These costs reflect changes to both forestry and pulp mill operations; saw mill operations would remain unchanged under the different options.

For the "Balance Sheet of Natural Forest Capital," the year end commercial value of the forest is recorded as an asset with value $40 million, the present value calculated by the company's chief cost accountant. Another important decision is assigning ownership of the forest. If the forest belongs to our parents, then it is an inheritance, and should be entered as equity. If, however, ownership is assigned to our children, then it should be entered as a liability—a loan to us from them. Although this decision is ultimately based on our values, the accounting principal of conservatism requires it to be treated as a liability. To account for damage done to the forest due to actions of this generation, an account receivable from the current generation of $7 million was entered. This value was calculated based on the money the company would have spent if it had been implementing the sustainable development option (Option 3).

Finally, the cost associated with risk to the ecosystem was estimated based on a number of factors, including the capitalized value for the forest (based on company annualized earnings) and estimates of the ecological impacts associated with the three options. This amount, which serves as a crude proxy for a depletion cost for the ecosystem. As expected, the depletion cost is greatest for Option 1 ($10.6 million) and lowest for Option 3 ($2.7 million).

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS In essence, what the analysis shows is that return on investments range from 27.0 percent for Option 1 being implemented in both the Forestry and Pulp Mill operations, to 15.6 percent for Option 3 being implemented in both operations. Including the depletion of the natural resource base reduces the rate of return to Option 1 to 23.7 percent, and the return to Option 3 to 14.8 percent. The much lower decline in this Full Cost Rate of Return in Option 3 is attributable to its much lower impact on resource depletion.

CONTACT Daniel Blake Rubenstein, Office of the Auditor General, Ottawa, Canada.

SOURCE Rubenstein, Daniel Blake, "One Man's Attempt to Reconcile the World of Accounting with his Love of the Forest". *CA Magazine*. October 1994.

SOUTHWEST HYDRO, INC.

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Does improved estimation of operating costs enhance the utility's ability to identify environmental savings?

BUSINESS BENEFITS

By measuring the C$10.4 million in environmental costs, Southwest Hydro identified C$1-3 million in potential savings.

COMPANY PROFILE

⇒ *Location*: Southwestern Ontario

⇒ *Size*: 75,000 customers

⇒ *Annual Revenues*: C$148,500,000

⇒ *Business*: Retail arm of North America's largest utility

WHY WAS PROJECT PERFORMED?

In conjunction with its parent, Ontario Hydro Retail, and the Environment and Sustainable Development Division of Ontario Hydro (OH), SWH undertook a pilot project to review and analyze the environmental impacts of the utility's operations. The purpose of the project was to identify the operations' environmental costs and to develop recommendations for process improvements to reduce or avoid costs, increase revenues, reduce waste, and enhance SWH's image in its host communities. The intended outcome would enable SWH to better manage its environmental costs and future liabilities and to establish benchmarks for other utilities in Ontario Hydro Retail.

The project was a part of the Sustainable Energy Development Strategy at Ontario Hydro. OH and its business units have been developing methods to integrate environmental considerations into its decision making. This study is a pilot of one method, called Full Cost Accounting (FCA) by OH, which ultimately is intended for deployment throughout the corporation. The FCA was part of former Chairman Maurice Strong's strategy to restructure the company to meet the dual challenges of a dynamic utility industry and sustainable development.

PROJECT DESCRIPTION

The project collected and analyzed the costs of SWH processes and operations with direct or indirect environmental impacts. Environmental costs, in this context, are defined as capital and operating expenditures of initiatives to protect and restore the environment. It did not quantitatively include external environmental costs, or externalities.

The collection and compilation of these costs was hampered by the absence of a separate record of environment-related expenditures. Once the operations having environmental impacts were identified, environmental costs were estimated from available data, including interviews with utility personnel and actual expenditures data from 1994-5. These costs, and their associated drivers, were quantified to develop recommendations to lessen the environmental impacts of SWH's processes and operations.

ANALYSIS

The internal review of environmental costs thoroughly examined SWH's operations. The utility developed an input/output model of its operations in which six major categories of processes were identified. Within these categories reside the activities that drive environmental expenditures due to their environmental impacts. The costs associated with these activities were ascertained to the extent possible and included in the overall assessment of SWH's environmental costs. For two of the categories, discrete environmental costs could not be separately identified; in these cases, the full costs of the processes were included. Capital costs were annualized based on the expected frequency of occurrence.

SOUTHWEST HYDRO, INC.

For each of the processes, the utility identified the inputs and outputs associated with the relevant activities, i.e., those having an environmental impact. Costs were assigned to these inputs and outputs based on available data and estimation providing widely varying degrees of quantitative rigor. For the six environmental cost categories, a total of 23 activities were included in the analysis, although 11 of these did not represent a measurable cost or, in some cases, represented a cost avoidance. The activities covered a variety of environmental costs as diverse as 'green' procurement, herbicide use, contaminated land management, settlements with Aboriginal peoples, and renewable technology development.

COST CONSIDERATIONS

	Annual Savings
Line Loss Reduction	$ 1,000,000 to 2,000,000
Fuel Efficiency	$ 30,000 to 80,000
Transformer Mgmt.	$ 50,000
Solid Waste Reduction	$ 20,000
Haz. Waste Reduction	$ 10,000
Landscaping	$ 25,000 to 50,000
PCB Management	$ 25,000 to 50,000
Total Savings	$1,160,000 to $2,260,000

FINANCIAL PARAMETERS

Not applicable.

FINANCIAL RESULTS

The total cost of SWH's operations and processes that have environmental impacts was estimated to be nearly C$10.4 million, roughly 8% of total operating costs. Costs associated with waste management accounted for C$7.7 million of that total, driven largely by the costs associated with energy loss from distribution inefficiencies. Land use management accounted for another C$1.5 million due in large part to the costs of line clearing and other forestry work.

This costing exercise enabled the identification of opportunities for cost reduction and avoidance, revenue generation, and environmental improvement. These opportunities have a potential cost savings totaling C$1.2 million to C$2.8 million, which would increase net income by 5-15%. These numbers did not include savings that could not be readily quantified nor those attributable to intangible benefits such as improved corporate image and electromagnetic field reduction. The study concludes with both specific and general recommendations for achieving cost savings and for continuing to improve SWH's ability to track and manage environmental costs.

CONTACT

Ali Khan, Southwest Hydro, (416) 592-4788
Head Office, Ontario Hydro, (416) 592-5111

SOURCES

Southwest Hydro and Ontario Hydro Retail, *Internal Environmental Cost Review of Southwest Hydro*. May 1996.

US Environmental Protection Agency, *Environmental Accounting Case Studies: Full Cost Accounting for Decision Making at Ontario Hydro*. EPA 742-R-95-004, 1996.

BAXTER INTERNATIONAL

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Are expenditures on an internal environmental management program financially justified?

BUSINESS BENEFITS

From proactive spending of $22.2 million, Baxter realized annual environmental income, savings, and cost avoidance of $23.4 million, plus another $51.2 million in cost avoidances from previous years.

COMPANY PROFILE

⇒ *Location*: Deerfield, IL

⇒ *Size*: 184 sites worldwide

⇒ *Annual Revenues*: >$9 billion

⇒ *Business*: Producer of products and services used in hospitals and other health care facilities

WHY WAS PROJECT PERFORMED?

Over the years, Baxter has demonstrated a strong commitment to improving its environmental performance. In setting and achieving waste reduction goals, making voluntary environmental commitments, and adopting a progressive environmental policy, Baxter has taken strides to go beyond compliance and to integrate environmental considerations into its business. It has developed a number of specific initiatives to improve its environmental performance as part of the normal course of doing business.

One of these initiatives was the development of a financial statement of the company's costs and cost savings associated with its environmental activities. Referred to internally as the environmental balance sheet, the statement has been refined and upgraded, and has been published for external audiences since 1992. The UK telecommunications company, British Telecom, sponsored this case study of Baxter's environmental financial statement as part of a research effort to improve its own environmental reporting.

PROJECT DESCRIPTION

The central theme of Baxter's environmental financial statement is that environmental considerations are an integral part of running its business. Furthermore, good environmental management requires not just the consideration of environmental issues, but their translation into bottom-line language that speaks to upper management. The environmental balance sheet is a demonstration of the economic benefit of the firm's environmental activities.

The statement serves multiple purposes within the company, and these are mostly for internal uses. The first is to reinforce the firm's commitment to total quality management and its logical extension to environmental management. By measuring the costs of action and inaction, the case that good environmental management is consistent with good business is made more compelling. Such measurement induces managers to take positive actions that can yield simultaneous environmental and economic benefits. Other purposes of the balance sheet are to identify future cost savings opportunities and to enhance the credibility and perceived value of environmental staff. The statement also serves the purpose of informing its external stakeholders of its financial commitment to environmental performance.

ANALYSIS

The development of the statement requires the identification, collection, and assembly of financial data associated with all aspects of environmental affairs. The statement separates the data into two categories: environmental costs; and total income, savings, and cost avoidance for initiatives undertaken in a reporting year. The cost avoidances from previous years are then added to arrive at the total benefit of Baxter's environmental initiatives. The estimation of

cost avoidances does not include costs that would have been eliminated through other means. The data collection is an annual process facilitated by a form distributed to all Baxter divisions. Corporate staff synthesizes and verifies the data to the extent possible in order to maintain the statement's credibility.

COST CONSIDERATIONS

	1994 Savings
Materials/Disposal	$ 9,100,000
Recycling Income	$ 3,500,000
Energy Conservation	$ 300,000
Packaging	$ 10,500,000
Total Savings	**$23,400,000**

	1994 Costs
Corporate, Etc.	$ 2,800,000
Programs	$ 9,100,000
Pollution Control	$ 10,300,000
Total Costs	$22,200,000

The environmental costs are split into the proactive costs of the basic environmental program and the reactive costs of remediation and waste disposal. These costs are measured in terms of the quantity of the resource used (e.g., materials, equipment, or staff time) and the price the company pays for the resource. Environmental benefits include cost reductions of ozone-depleting substances, hazardous and non-hazardous waste, and packaging; income from recycling; and cost savings from energy conservation. Although the statement aims to be comprehensive, certain cost elements are excluded from the analysis for a number of reasons. These items include reduction of liability exposure, increased goodwill and employee morale, capital cost differential for environmentally superior lighting, and costs of environmentally-driven R&D. Baxter sees these costs/savings as offset by non-environmental costs/savings, as relatively minor, or as too difficult to quantify.

FINANCIAL PARAMETERS

Not provided.

FINANCIAL RESULTS

The study provided environmental financial statements for 1994, 1993, and 1992. The total income, savings, and cost avoidance in 1994 was $74.6 million, up from $31.0 million in 1992. The 1994 environmental proactive costs were $22.2 million while the reactive program costs were $5.4 million. These costs were nearly offset by the year's savings and income of $17.7 and cost avoidances of $5.7, amounting to a total of $23.4 million. From these numbers alone, the investment in the proactive program was covered by the benefits it yields.

The statement also reports another $51.2 million of cost avoidance in 1994 from efforts initiated in prior years (dating back to 1989). This figure represents waste reduction initiatives from previous years that continue to represent money the company does not have to spend, but would have if the initiatives had not been taken.

INSTITUTIONAL CHANGE

Baxter has integrated environmental considerations into its business at all levels. The company continues to publish a comprehensive annual environmental performance report.

CONTACT

William Blackburn, Baxter International, (847) 948-4962

SOURCES

Baxter International, Inc., *Baxter Environmental Performance Report 1995*. 1996.

Bennet, Martin and Peter James, *Baxter International Inc. -- Environmental Financial Statement*. Study for British Telecommunications, March 1996.

CHRYSLER CORPORATION

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Should a mercury switch in an under-hood convenience lighting package for the calendar year 1997 Neon be selected over the other mercury-free alternative?

COMPANY PROFILE

⇒ *Location*: Auburn Hills, MI

⇒ *Size*: 120,000 employees

⇒ *Annual Revenues*: $40 Billion

⇒ *Business*: Car and Light Truck Manufacturer

BUSINESS BENEFITS

The apparent piece price difference was $0.12 in favor of the mercury switch; however, the relative cost savings when a total life cycle analysis was conducted indicated a $0.12 advantage for the rolling ball switch, the mercury-free alternative.

WHY WAS PROJECT PERFORMED?

Chrysler Corporation relies on a large automotive supplier base to manufacture its products. Chrysler evaluates the various components available from different suppliers by performing Life Cycle Management (LCM) studies, which compare components on the basis of not only piece price, but also environmental, health, safety, and recycling considerations in a systematic business decision framework. In addition to assisting with sound business decisions, environmental factors help measure Chrysler's readiness to comply with upcoming regulatory requirements and internal engineering standards.

LCM focuses on comparative evaluations of key life cycle segments. Chrysler developed an LCM model for evaluating production components with Franklin Associates, Ltd. In addition to piece price, inputs of the model include: recyclability and disassembly ratings, and recycled content data from Chrysler's Regulated Substance and Recyclability Certification (RSRC) Data Collection and Reporting System; tooling costs; component weight; substances of concern contained in the component; labeling requirements; storage costs; packaging costs; insurance premiums; environmental training; personal protective equipment; record-keeping and reporting; add-on environmental controls; end-of-life disposal and recycling costs; long-term liability; and emissions. The model results in a cost comparison of two or more available alternatives.

PROJECT DESCRIPTION

Convenience under-hood lighting systems have been available on the Neon for several years. The switches used to turn the under-hood lights on and off have historically contained mercury, a substance gaining more and more attention from environmental regulators. A Life Cycle Management study was conducted by Chrysler to evaluate the hidden costs associated with continued use of the mercury switches compared to other available lighting alternatives, and to determine the least expensive alternative.

ANALYSIS

Several alternative designs for convenience under-hood lighting systems are available in the automotive manufacturing industry. Options for mercury-free switches include pendulum, rolling ball, transistor, and limit switches.

The State of Minnesota has a statute in place prohibiting the crushing of a motor vehicle without prior removal of all mercury switches. Wisconsin and Michigan are following Minnesota's lead. Sweden has also banned mercury from motor vehicles sold in that country. To evaluate the cost impact to Chrysler Corporation, an LCM case study evaluated a mercury

switch currently in use, and two possible alternatives. Piece prices of the mercury switches are one-third to one-half of the piece prices of mercury-free switches. A cost savings can also be recognized by using similar switches across all Chrysler platforms, and getting volume discounts. No additional tooling costs are required for either type of switch, because both are currently manufactured by Chrysler.

COST CONSIDERATIONS

Mercury vs. Rolling Ball Switch (Mercury-free)	
Piece Price	$ - 0.11
Acquisition Price	- 0.01
Identification and Tracking	+ 0.24
The Total LCM Cost Advantage of the Rolling Ball Switch is:	**+ 0.12** per unit

Significant identification and tracking requirements are associated with mercury switches, and costs associated with tooling to manufacture labels, label piece price, and labor to install labels are calculated and included in the LCM cost. Product Destination Software will also be required for the mercury switches. This software is required to identify labels which are required or proposed for sales of vehicles in three states. The cost of labeling is related to the variety and difference required by the states. Additional environmental support from Chrysler's corporate staff to address regulatory and reporting issues will be required the first year of regulation.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS The comparison results in a significant cost savings by using the mercury-free rolling ball switch The savings is $0.12 per unit, or about $18,000 per year. The costs were driven to a large degree by labeling costs associated with a variety of requirements stipulated by three states. In addition to this cost savings, using the mercury-free switch supports Chrysler's internal engineering design standards, reduces potential liability, and reduces its regulatory burden.

INSTITUTIONAL CHANGE Chrysler has incorporated ECA into the set of decision tools is uses. It also makes extensive use of life cycle management. ECA has changed how Chrysler measures costs, but has not affected cost allocation.

CONTACT Wendy S. White, The Traverse Group, Ann Arbor, MI (313) 747-9301
Dr. Robert J. Kainz, Chrysler Corporation, Auburn Hills, MI (248) 576-5496
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SOURCE Pollution Prevention and Remediation, Chrysler Corporation, Life Cycle Programs

LARGE FIRM IN AUTO INDUSTRY

BUSINESS DECISION

PRODUCT/PROCESS COSTING

Can improved estimation of potential environmental liability costs enhance the firm's ability to identify environmental savings?

BUSINESS BENEFITS

A thorough analysis of potential environmental liability costs projected savings of over $1,000,000 per year.

COMPANY PROFILE

⇒ *Location*: Midwest US

⇒ *Size*: >100 facilities worldwide

⇒ *Annual Revenues*: >$10 billion

⇒ *Business*: Manufacturer in automobile industry

WHY WAS PROJECT PERFORMED?

This firm was concerned about managing potential environmental liability costs associated with the continued use of transformers containing PCBs. An internal environmental team previously conducted a life-cycle analysis of the business-as-usual scenario of replacing the PCB transformers through normal attrition. This preliminary analysis included both conventional costs as well as what the team called environmental costs and risks, but failed to provide sufficient financial justification for a managed corporate-wide phase-out.

Because the project would require an investment of tens of millions of dollars, management wanted to be sure the financial analysis was thorough, conservative, and sound. With assistance from Tellus Institute, the firm sought to assess the previous analysis and develop a methodology for the consideration of contingent liability costs. Tellus worked with the firm to identify these costs and reassess the financial viability of a managed phase-out program.

PROJECT DESCRIPTION

At the time of the study, this firm managed hundreds of PCB-containing transformers. The project aimed to fully assess the liability the company faced as a result of maintaining these transformers during their normal lifetime. Allowing the transformers to be gradually phased out, the business-as-usual scenario, would take an estimated 30 years, whereas the managed phase-out would be completed in 5 years.

To support its economic evaluation, the firm sought to determine the probability and costs of acute events related to the PCB-containing transformers; including costs of insurance, litigation, clean-up, production shutdown, regulatory penalties, and possible effects on the firm's corporate image. The original economic analysis accounted for liability resulting from leaks, spills, and ruptures, but failed to consider transformer fires. Furthermore, the previous analysis did not consider repercussions in the production chain in this vertically-integrated company, effects that could have significant financial impact. The credibility and validity of liability estimates would have to be defensible and acceptable to obtain upper management's approval.

ANALYSIS

The analysis used actuarial techniques as the basis for developing expected values for contingent liability costs. Historical information was gathered from a number of sources to estimate and substantiate the probability and associated costs of various events. A framework was first established to identify the potential costs of an acute event, thereby suggesting the types of data necessary to estimate such costs. The most significant costs were the clean-up, insurance, litigation, and production shutdown and losses that would result from a transformer fire or spill. All of these costs, therefore, were contingent on the occurrence of each of the

possible events. The ultimate cost to the company is the probability of each event times the magnitude of its respective cost, summed over all events.

COST CONSIDERATIONS

Contingent Costs per Transformer Incident

	Spill	Fire
Clean-Up	$ 339	$ 140
Litigation	$ 3,213	$ 68
Lost Production	$ 1,560	$ 10
Total Costs	**$5,112**	**$218**

The probabilities of each event – a transformer spill and a transformer fire – were estimated using historical databases of actual transformer incidents gathered from publicly-available sources. The costs of clean-ups and litigation similarly were determined by research that provided data on transformer events. Litigation costs were those that would result from personal injury lawsuits relating to chemical exposure and industrial accidents. The analysis considered but finally excluded insurance cost increases because the firm self-insures to cover liability. The final element in the analysis was the consideration of the production effects of an acute event. Because of the high volume and vertically-integrated nature of the firm's operations, cascading effects of a shutdown could be significant. This part of the analysis considered production level, inventory, output value, and the functional relationship between facilities.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS The annual total contingent costs per PCB-containing transformer were estimated to be $218 for a transformer fire and $5,112 for a transformer spill (using this expected-value, risk-based methodology). Using these costs, just 200 transformers would represent over one million dollars of contingent cost to the company. This is the business-as-usual cost associated with continued use of the PCB-containing transformers.

The values for the annual costs were determined as the aggregate of the various cost components and their associated probabilities. The contingent cost of a spill – itself a 0.0034 probability – was estimated as $339 for clean-up, $3,213 for third-party litigation, and $1,560 for a production stoppage. For a fire – a 0.000018 probability – the costs were $140, $68, and $10 respectively. For the hundreds of PCB-containing transformers managed by this company, these costs quickly escalate into millions of dollars in annual contingent costs.

CONTACT Allen White, Tellus Institute (617) 266-5400

SOURCE White, A.L., D.E. Savage, and A. Dierks, "Environmental Accounting: Principles for the Sustainable Enterprise". Originally presented at the 1995 TAPPI International Environmental Conference, Atlanta Georgia, May 7-10 1995.

CELANESE ENGINEERING RESINS, INC.

COMPANY PROFILE

⇒ *Location*: Bishop, TX

⇒ *Size*: 1,100 employees

⇒ *Annual Revenues*: Hoechst Celanese as whole has $6.9 billion in US sales

⇒ *Business*: Manufacturer of bulk organic chemicals, engineering plastics, and bulk pharmaceuticals

BUSINESS DECISION

STRATEGIC PLANNING

Study of potential environmental projects for meeting the facility's release reduction goals.

BUSINESS BENEFITS

The selection methodology used resulted in revealing the group of waste minimization projects that would meet corporate goals at the lowest cost.

WHY WAS PROJECT PERFORMED?

Celanese Engineering Resins is a wholly-owned subsidiary of Hoechst Celanese Corporation, part of Hoechst AG, the German-based diversified company. In 1991, Hoechst Celanese committed to an ambitious corporate-wide program to reduce overall chemical releases at its 21 U.S. facilities by 80 percent before 1998. In addition, the company made a further commitment to a 70 percent reduction in releases of chemicals listed on the EPA's Toxics Release Inventory (TRI).

A key strategy for this effort is to use a hierarchy of waste management options that emphasizes reuse or elimination of waste at the source over treatment or release of wastes. The hierarchy used is: 1) sale of material as product; 2) source reduction; 3) recycle or reuse; 4) fuel value recovery; and, 5) treatment.

The Bishop facility wished to develop a methodology to identify and prioritize projects to meet the reduction goal specified for the facility under this program in the most effective manner.

PROJECT DESCRIPTION

The Bishop facility is a decentralized multi-production unit plant, with knowledge of waste streams and waste reduction technology residing in various groups. The facility used a team approach to bring the diverse sources of waste minimization information together to develop a comprehensive list of projects for the whole facility. Once potential projects were identified, engineering cost estimates were developed, as were release reduction estimates.

Following initial project identification, it became clear that most projects reduced liquid effluent. In an effort to assure that all such projects were identified, the facility compiled an overall plant liquid effluent balance. This allowed effluent streams to be compared with header measurements and total feed to the waste water treatment facility to verify that all significant effluent streams had been identified. Area representatives were asked to reassess waste minimization opportunities for the top five effluent streams in each area to insure that all options for key streams were considered.

Once the universe of waste minimization opportunities was identified and specified, the task of ranking them began. The first step is to calculate a waste minimization cost factor for each individual project. This factor compares the cost of reducing the waste through the project with the cost of treating the waste in the wastewater treatment facility. The factor is modified by the probability of success for the waste minimization project. A project with a factor

greater than 1.0 was economically superior to the water treatment plant. This provided an initial cut at identifying the most effective projects.

As the evaluation of waste minimization projects progressed, a more rigorous prioritization method was used to compare release reduction projects for all Hoechst Celanese facilities. The net present value of each project, including capital, operating costs, and economic benefits related to each project, such as raw material recovery or incremental product sales. The ratio of net present value to tons of release reduction (i.e., $/ton) is used to compare projects selected at the facility level.

ANALYSIS Using the rigorous comparison methodology discussed above, Hoechst Celanese identified the 150 projects at all U.S. facilities that would allow the corporation to meet its release reduction goal at the lowest cost.

A comparison of these projects provides several insights:

- fewer than 20 percent of the projects have a positive cost impact, although another 20 percent have net costs very near zero;
- projects to reduce SARA wastes are generally more costly than those that reduce non-SARA wastes;
- projects that recover product for sales and some recycling projects produce a net benefit, while source reduction and treatment projects generally do not;
- in several instances, voluntary release reduction projects were significantly less expensive than projects mandated by regulation.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS Fewer than 20 percent of the projects have a positive cost impact. The other 80 percent add to production costs, but have long-term payout in that they may be cheaper than waiting for more stringent regulations and reacting with less-than-optimum solutions. Most projects that recover product for sales and some recycling projects had positive short-term economics. No source reduction or treatment projects did.

CONTACT Not provided.

SOURCE Kirk, Jeffrey, "A Methodology for Waste Minimization Project Selection as a Hoechst Celanese Manufacturing Facility". *Pollution Prevention Review.* Spring 1994.

DUPONT DE NEMOURS

BUSINESS DECISION

STRATEGIC PLANNING

Can improved costing of environmental operations inform management decision making?

BUSINESS BENEFITS

This DuPont facility identified a preferred method of waste treatment with variable costs more than 50% lower than the existing method.

COMPANY PROFILE

⇒ *Location*: LaPorte, TX

⇒ *Size*: >100,000 employees

⇒ *Annual Revenues*: $40 billion

⇒ *Business*: Producer of agricultural pesticides

WHY WAS PROJECT PERFORMED?

As the largest chemical company in the US, DuPont has found itself subject to intense scrutiny and criticism with regard to its environmental performance. Its longtime use of deep well injection (DWI) of wastewater placed the company at the top of the nation's Toxics Release Inventory. In light of this unfavorable attention, the company made a public commitment to positive action to improve its environmental performance.

With its large expenditures on environmental management ($500 million in 1993 for environmental capital projects and roughly $1 billion in environmental expenses), DuPont had much to gain by thoroughly understanding and actively managing its environmental affairs. To that end, DuPont developed and implemented a Corporate Environmental Plan (CEP), part of which focused on assigning priorities to environmental initiatives. The CEP embodies DuPont's environmental commitment by establishing a framework for collecting information, ensuring compliance, and meeting internally-established and externally-publicized goals. One of these goals is the elimination of land disposal, including DWI, of hazardous wastes by the end of the decade.

PROJECT DESCRIPTION

The CEP integrates environmental issues into business planning by providing guidelines for developing environmental projects and identifying the regulations, technologies, and required resources relevant to each project. The cost per pound of waste eliminated provides a comparative metric to prioritize these environmental initiatives, subject to additional consideration of timing and potential synergy with other projects. The development of a cost metric requires a means for identifying and tracking all relevant costs. At the time of this study, the LaPorte facility was establishing an environmental accounting system to enable development of these measurements.

The agricultural pesticide manufactured at LaPorte generates liquid and solid wastes and air emissions. Some of the wastewater from the process is managed with DWI, and some is sent to an on-site biological treatment facility. Other waste streams from the process are incinerated. To achieve corporate environmental objectives, the LaPorte facility seeks to discontinue the use of DWI to dispose of its wastewater. To do so, the facility would have to rely on on-site treatment to process all of the facility's wastewater.

ANALYSIS

To analyze the financial aspects of the elimination of DWI for the process wastewater, DuPont executed a multi-step costing process to determine the environmental costs of the product, one of which was the cost of wastewater disposal by DWI. First, the various environmental costs of two types are identified: (1) Those already specified as environmental – such as waste

management and regulatory compliance – and (2) environmental costs hidden within other costs – such as management time spent on environmental activities. The plant estimates that 90% of the environmental costs are captured in these two cost elements. Environmental costs are disaggregated and categorized as fixed or variable, and then further categorized as controllable or non-controllable.

COST CONSIDERATIONS

Estimated Site Environmental Costs	
Taxes, Fees, Legal, etc.	21.0%
Depreciation	16.8%
Operations	13.9%
Waste Disposal	12.4%
Utilities	11.9%
Salaries	9.6%
Maintenance	8.5%
Engineering Services	6.0%
Total	**100%**

To evaluate the cost of wastewater treatment, the company allocated the full costs of the various treatment options to units of production based on estimated wastewater output. Shortcomings of this method include the inaccuracy of using output volume estimates and the assignment of fixed costs of waste treatment – costs which were incurred in the past and are now "sunk" – to products. To address the former, the facility has installed meters so that actual output data can be used. The allocation method was improved by ignoring the fixed costs and assigning only the variable costs to production units.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS Varying allocation methods for waste treatment had a significant effect on waste management costs. DWI had been costed at 9¢ per pound of effluent treated, of which 7¢ was variable cost. Bio-treatment appeared as a more expensive option at 11¢ per pound, but only 3¢ of that was variable cost. Whereas managers previously had incentive to use DWI to incur less cost through the accounting system, the improved allocation demonstrated that bio-treatment was actually more cost effective by 4¢ per pound.

The amount of savings this improved accounting method will yield depends on both the production volume and the actual volume of wastewater generated, as well as the extent to which the cost assignments remain stable. Nevertheless, the improved environmental accounting practices will enable DuPont to realize a substantial cost savings by eliminating disposal via DWI. At the same time, it will provide managers with better information with which to make future waste management decisions.

CONTACT Miriam Heller, University of Houston (713) 743-4193
Daryl Ditz, World Resources Institute (202) 662-3498

SOURCE Ditz, Daryl, Janet Ranganathan, and R. Darryl Banks, *Green Ledgers: Case Studies in Corporate Environmental Accounting*. World Resources Institute, May 1995.

WITCO CORPORATION

BUSINESS DECISION

STRATEGIC PLANNING

Can materials and cost accounting enhance the firm's ability to identify and prioritize environmental projects?

BUSINESS BENEFITS

Witco's analysis of its material flows and associated costs facilitated a plan that included a $30,000 cost savings opportunity.

COMPANY PROFILE

⇒ *Location*: Newark, NJ

⇒ *Size*: 60 employees (at this site)

⇒ *Annual Revenues*: $2 billion (total)

⇒ *Business*: Producer of fatty acids, glycerin, and esters used for the manufacture of plastics, rubber, and personal care and pharmaceutical products

WHY WAS PROJECT PERFORMED?

The New Jersey Pollution Prevention Act was developed to help businesses overcome the barriers that typically inhibit pollution prevention (P2). The Act mandated a planning process to encourage companies to identify opportunities for environmental improvement. To further an assessment of the success of the Act, the state Department of Environmental Protection commissioned case studies of five firms to evaluate their experiences with the planning process.

Witco was among the first firms in the state to fulfill the Act's planning requirements, was willing to share its experiences, and was identified as having prepared a successful plan. The study sought to assess how the facility implemented the planning process, what lessons it learned, and what implications could be drawn for the state's planing process.

PROJECT DESCRIPTION

One of the elements of the planning process is the development of facility and process materials inventories. The Act requires facilities to quantify their use and generation of hazardous wastes and to estimate the associated costs. The process of measuring these costs is intended to establish a framework within which the facility can fully understand and benchmark its processes to inform P2 management decisions.

Witco first had to define its discrete manufacturing processes and identify the locations where wastes exit each process. The facility then had to collect both facility-wide and process-level material throughput data. The final step of this element of the planning process was the assessment of costs associated with hazardous materials.

ANALYSIS

The collection of materials throughput data required an augmentation of practices already in place to calculate facility-wide totals for Toxics Release Inventory reporting. The significant change was shifting the unit of analysis from the facility to the individual processes. The facility gathered the process-level data by performing materials balances for each process. To do so, it compiled accounting information from numerous departments to estimate the quantity of chemicals stored in inventory, processed, brought on site, recycled, wasted, and embodied in products. To verify the accuracy of the information, the facility took selected measurements of one chemical in order to compare the estimate to the actual use. The planning process also required the facility to normalize the data so that it can be evaluated independent of production volume. Finally, the facility allocated costs – both input (purchase) costs and output (waste disposal) costs – to the specific processes.

Once the first level of analysis was complete, the ultimate value-added component of the planning process could be implemented: identification and analysis of P2 opportunities. Since the audit had identified the various sources and costs of waste generated at different stages of the individual processes, the facility had the information it needed to make improvements. As a result of the planning process, capital investment ideas were developed at the facility as opposed to at the corporate level, and the focus of these investments shifted upstream in the process. From the information collected, the benefits of proposed investments could be more readily evaluated.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS Throughout the planning process, the facility expected to reach its goal of reducing the use of methanol by 28,000 pounds annually. This reduction will create a savings to the firm of $30,000 in material and effluent costs. The quantitative nature of the planning process facilitated setting reduction goals and the evaluation of proposed projects to achieve those goals. For example, when the sewerage charges stemming from methanol use were allocated to the processes generating methanol and its use was normalized for production level, the inefficient use of methanol and the high associated cost became evident. Management could then adequately assess the direct economic benefits of improving process efficiency and reducing the use and generation of a costly input material.

CONTACT Allen White, Tellus Institute (617) 266-5400

SOURCE Dierks, Angela, Allen White, and Karen Shapiro, *New Jersey's Planning Process: Shaping A New Vision of Pollution Prevention*. June 1996.

THE ROBBINS COMPANY

BUSINESS DECISION

STRATEGIC PLANNING

Study of a newly-installed closed-loop system to filter and purify wastewater, recover metals, and eliminate discharge.

COMPANY PROFILE

⇒ *Location*: Attleboro, MA

⇒ *Size*: 330 employees

⇒ *Annual Revenues*: $30 million

⇒ *Business*: Metal finisher and plater. Specializes in small, customized jobs.

BUSINESS BENEFITS

For an investment of $220,000, the Robbins Company reaped $117,000 in annual savings over original system. In addition, there were savings due to considerable fines and penalties the company would have accrued. Many of these benefits were not anticipated.

WHY WAS PROJECT PERFORMED?

The Robbins Company is a privately held company with sales of approximately $30 million. The firm's primary business is the custom designing and manufacturing of jewelry, awards, and promotional items. Most of the company's products require electroplating with valuable metals, such as gold or silver. The electroplating process requires large amounts of water and chemicals, and leaves behind a host of toxic residuals in the wastewater.

Robbins managed this wastewater through an antiquated, inefficient system of settlement tanks, dating back to the era prior to serious pollution regulation. The system failed to remove a quarter of the water's waste, and as a result, the company would routinely violate it discharge permit and emit many times the allowed amount of waste into the brook. The fines resulted in such a large financial toll that the company's chief financial officer took over responsibility of the company's environmental management. In 1986, the company hired its first environmental manager, and gave him the resources and authority to bring Robbins into compliance.

In 1987, Massachusetts regulators announced a plan to dramatically reduce discharges from all sources into the river into which Robbins discharges. To meet the more stringent standards would require Robbins to construct a large, very expensive wastewater treatment facility. The environmental manager began to investigate the concept of developing a zero-discharge system.

The environmental manager estimated that the closed-loop system required an initial investment of $250,000 to $300,000. Although this comprises more than half of the company's annual capital expenditure budget, it was less than half the cost of installing a new wastewater treatment system. However, the closed-loop system came with many uncertainties—foremost among them uncertainty as to whether the system would even work. Initial contacts with Massachusetts technical assistance personnel indicated that such a system was feasible, although none was actually in operation in a similar facility. Nonetheless, the company president was supportive, as a zero-discharge system would remove the company from its debilitating struggle with regulations.

PROJECT DESCRIPTION

The design of the zero discharge system evolved through the combined efforts of the Robbins Company, the Massachusetts technical assistance program, and the engineering firm hired by the company. The final design was composed of two subsystems: one for wastewater

purification and one for metal recovery. The water produced by the wastewater purification subsystem was forty times cleaner than city water, and contributed to greater plating quality. The subsystem is designed with parallel filters and resins, allowing continued manufacturing during scheduled maintenance.

COST CONSIDERATIONS

	Annual Savings Over Old System
Water Usage	$22,000
Chemical Use	$13,000
Sludge Disposal	$28,000
Recovered Metal Sales	$14,000
Laboratory Analysis	$40,000
Total Annual Savings	**$117,000**

The metal recovery subsystem uses electrolytic recovery to plate out metals captured in the water purification subsystem. Only *two pounds* of sludge are produced annually in the metals recovery subsystem. Because this sludge is composed of almost pure metal, it is more valuable to a refiner than precipitated sludge.

The closed-loop system requires close coordination among all facility operations, as it is an integrated part of the manufacturing process, rather than an add-on, end of pipe solution. This means that, for example, the environmental manager must approve the introduction of any new plating chemistry into the system. With clear authority from top management, the environmental manager worked with floor managers and machinery operators to get buy-in on the new operations. This buy-in was eased, in part, because it was clear to all that the survival of the company itself was at stake.

ANALYSIS

Upon completion of the system, the company realized it had not just been successful in achieving complete regulatory compliance, but that the new system was a major financial, risk reduction, and public image success. The investment of $220,000 led to substantial savings. The new system uses 500 gallons of water per week (to replace evaporative loss), compared to 500,000 per week in the old system. This results in an annual savings of $22,000. The new system reduces chemical usage ($13,000/year) and produces less toxic sludge ($28,000 in annual hazardous waste disposal and $40,000 in reduced laboratory analysis). In addition, the company receives $14,000 in annual revenue from sale of metals recovered from sludge. In total, the annual operating costs savings of $117,000 mean the system will pay for itself in about two years, even when the annual operating costs of $30,000 are taken into account.

Furthermore, the company benefited in additional ways, not all of them directly financial. Product quality has improved due to the purer water from the closed system. Sales have increased, due in part, at least, to publicity surrounding Robbins' pollution prevention program. An impending lawsuit was dropped, saving Robbins costly litigation. Robbins was protected from an interruption of water supply, which caused other businesses several days of lost production. Finally, Robbins was protected from any future tightening of regulations.

FINANCIAL PARAMETERS

Not provided.

FINANCIAL RESULTS

Robbins accrues $117,000 in annual savings over the original system for a $220,000 capital investment. This savings does not include those due to considerable fines and penalties the company would have accrued in the near future had they continued to operate outside of compliance.

THE ROBBINS COMPANY

CONTACT Not provided.

SOURCE Berube, Michael, et al., "From Pollution Control to Zero Discharge: How the Robbins Company Overcame the Obstacles". *Pollution Prevention Review.* Spring 1992.

SANDOZ PHARMACEUTICALS

BUSINESS DECISION

STRATEGIC PLANNING

Study of impact of comprehensive pollution prevention planning in a major pharmaceutical manufacturer.

BUSINESS BENEFITS

Sandoz was pleased to find that many opportunities for pollution prevention (P2) were cost effective. On average, P2 projects provided a 16.3% return on investment.

COMPANY PROFILE

⇒ *Location*: East Hanover, NJ (U.S. Corporate HQ and R&D operation)

⇒ *Size*: 1,600 employees on site

⇒ *Annual Revenues*: U.S. sales of $1.4 billion

⇒ *Business*: Pharmaceutical manufacturing

WHY WAS PROJECT PERFORMED?

Sandoz Pharmaceuticals is an affiliate of the Swiss-based Sandoz Corporation, which employees 36,000 worldwide. The East Hanover, NJ facility if one of three U.S.-based Sandoz operation. The facility houses the U.S. corporate headquarters and the Sandoz Research Institute, and R&D operation. The facility manufactures 26 products using 25 different batch processes.

The pharmaceutical industry presents a singular challenge to the P2 due to a convergence of factors: 1) much of the cost of a product is in its development rather than its manufacture; 2) one a drug is patented, the clock on its patent begins to tick, encouraging the fastest possible path to the market; 3) U.S. Food and Drug Administration (FDA) approval is required for any changes in the manufacturing process. Together, these factors lead to very limited P2 opportunities once manufacturing has started.

The New Jersey Pollution Prevention Act requires facilities to carry out a specified planning process, entailing the collection of a range of throughput data for each process and for the facility as a whole. Total costs of using or generating hazardous substances must also be calculated for each process.

The case study on which this snapshot is based was undertaken by the State of New Jersey to learn the effectiveness of the P2 planning process for a pharmaceutical manufacturer.

PROJECT DESCRIPTION

Prior to the New Jersey planning process, Sandoz had a proactive policy of pollution prevention as part of its corporate environmental policy. As part of these efforts, Sandoz carried out a number of P2 initiatives, including: computerizing chemical inventory (18% reduction in chemical use); eliminating use of chlorinated solvents; reducing use of virgin feedstocks; reducing flow of nitrogen blankets (needed to protect reactions from oxygen), thereby reducing associated solvent vapors; purchasing solvents in larger quantities to reduce packaging waste.

In Sandoz's operations, waste data are equivalent to throughput data, as chemicals (solvents) are neither embodied in products nor consumed in processes. Prior to the P2 planning process, Sandoz was keeping track of the amount of solvent required per pound of product in the form of a waste index. This information had been gathered to track hazardous material flows. The P2 planning process made use of this and other information to expand evaluation of P2 opportunities to include consideration of opportunities *within* processes. Prior to the P2

planning process, these processes were considered "sacred cows" owing to the requirement of FDA approval for process changes. The planning process resulted in the company overcoming this unwillingness and uncovering several opportunities to improve processes.

ANALYSIS Due to corporate commitment to improving environmental quality, Sandoz decided to implement any P2 project that resulted in at least a ten percent reduction in releases, regardless of cost. To its surprise, the facility found that many of these opportunities were cost-effective. One example of a process improvement that resulted from the planning process involves a change in a solvent that requires FDA approval. The change resulted in a 95% decrease in solvent use, reduces production time by 80%, and decreases energy requirements by 60%. None of these benefits would have come about without the P2 planning process.

Sandoz projects a 53% reduction in multi-media releases from the P2 opportunities it implemented based on the planning process. In addition, Sandoz anticipates the planning process will help it get off the "treadmill" of increasingly stringent regulatory requirements.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS Sandoz decided to implement any P2 project leading to at least a 10% reduction in releases. Sandoz projects a average 16.3% return on investment in P2 activities. Although this is below the typical Sandoz hurdle rate of 40%, it was judged by Sandoz to be "respectable".

CONTACT Karen Shapiro, Tellus Institute (617)266-5400.

SOURCE Dierks, Angela, Allen White, and Karen Shapiro, *New Jersey's Planning Process: Shaping A New Vision of Pollution Prevention*. June 1996.

UNIFOIL CORPORATION

BUSINESS DECISION

STRATEGIC PLANNING

Study of the impact of comprehensive pollution prevention (P2) planning in a small coatings firm.

COMPANY PROFILE

⇒ *Location*: Passaic, NJ

⇒ *Size*: 90 employees

⇒ *Annual Revenues*: $40 million

⇒ *Business*: Coating of papers with metal and metallized plastics

BUSINESS BENEFITS

Prior to undertaking the P2 planning process, Unifoil had bundled all environmental costs into overhead accounts. Allocation of these costs to specific processes results in a much better understanding of costs associated with using solvents. Eliminating solvents will result in expected annual savings of $393,000.

WHY WAS PROJECT PERFORMED?

Unifoil Corporation has a single facility in Passaic, New Jersey. The facility's 90 employees manufacture paper and other substrates coated and laminated with metal foils and metallized polyester. The company's customers manufacture products such as packaging and lottery tickets from the materials they purchase from Unifoil.

The facility applies coatings to substrates using either water-based or solvent-based adhesives containing volatile organic compounds (VOCs). Because VOC emissions are tightly regulated, Unifoil vents such emissions via an oxidizer operating at 800º F, providing 99% VOC destruction.

The New Jersey Pollution Prevention Act requires facilities to carry out a specified planning process, entailing the collection of a range of throughput data for each process and for the facility as a whole. Total costs of using or generating hazardous substances must also be calculated for each process. Unifoil's experience with the mandated P2 planning process was examined as part of a series of case studies carried out for the New Jersey Department of Environmental Protection. The purpose of the case study is to help the state better understand motivations for P2 activities and changes in company. As such, the study does not contain detailed analysis of particular P2 activities.

PROJECT DESCRIPTION

Prior to the P2 planning process, the company was slowly reducing solvent use by moving to water-based alternatives. Although it had not fully identified the internal benefits of doing so, tight VOC regulation encouraged this move. However, due to incompatibility with conventional inks used by most customers, there was significant resistance, particularly from U.S. customers (resistance from overseas customers was much lower).

The P2 planning process requires allocation of emissions and related costs to specific processes. Prior to the P2 planning process, the company allocated such costs to overhead accounts. Once the allocation exercise was completed, management was surprised by the magnitude of the costs. This motivated the company to accelerate its consideration of P2 alternatives.

Working closely with a wide range of employees, including production workers, Unifoil identified a large number of P2 opportunities, including many of which management was previously unaware. None of the identified options required significant capital expenditures.

Generally speaking, the direct operating costs of using water-based coatings and solvent-based coatings are similar.

ANALYSIS Any reduction in solvent use, and therefore VOC generation and treatment, substantially reduces Unifoil's operating costs. Total elimination of solvent use would help Unifoil avoid regulatory requirements, bringing additional savings through avoided permitting and reporting costs. However, Unifoil cannot fully switch to a water-based formulation without the agreement of its customers due to the issue of ink compatibility. Unifoil is working with its customers to persuade them to shift their printing processes to be compatible with the water-based process, however, they must ultimately meet the needs of their customers.

The P2 planning process has resulted in a number of strategic benefits for Unifoil. The process revealed the "true" cost of using solvents, and enabled the company to see the long-term benefits of eliminating solvents to the maximum extent feasible. The second, somewhat unanticipated, major benefit was the forging of communications between production workers and management. This has, in effect, moved the facility in the direction of Total Quality Management, and has permanently integrated P2 into Unifoil's organizational framework.

FINANCIAL PARAMETERS Not provided.

FINANCIAL RESULTS Through the P2 planning process Unifoil discovered the true costs of using solvents that had previously been hidden in overhead accounts. The direct operating costs of water-based coatings are similar, but no treatment of VOC emissions is required. The company expects annual savings of $393,000 by eliminating solvents.

CONTACT Karen Shapiro, Tellus Institute (617)266-5400.

SOURCE Dierks, Angela, Allen White, and Karen Shapiro, *New Jersey's Planning Process: Shaping A New Vision of Pollution Prevention*. June 1996.

Appendix A – Glossary of Terms

Environmental accounting – national income accounting	incorporation of environmental costs into information used in national income accounts; may include data about a nation's or region's consumption, extent, quality, and value of natural resources, both renewable and non-renewable; sometimes referred to as Natural Resource Accounting
Environmental accounting – financial accounting	incorporation of environmental costs into information used in financial reports, especially of publicly-traded companies
Environmental accounting – management accounting	incorporation of environmental costs into information collected and used in making internal business decisions (e.g., capital investment decisions, costing determinations, process/product design decisions, performance evaluations, and a host of other forward-looking business decisions)
Environmental cost accounting	inclusion of environmental cost information in existing cost accounting practices; tracking environmental costs in existing accounts and allocating them to appropriate products or processes
Environmental costs	impacts incurred by society, an organization, or an individual resulting from activities that affect environmental quality; these impacts can be expressed in monetary or non-monetary terms
Activity-Based Costing	allocating costs to processes, products, or other cost centers based on the operational activities that drive them
Back-end costs	costs that arise following the useful life of current products, processes, systems, and facilities and will occur at reasonably well-defined points in the future (e.g., sealing a landfill, decommissioning an old facility, replacing a storage tank)
Capital budgeting	evaluating long-term investment decisions that require capital outlays
Contingent environmental costs	environmental costs that may occur in the future and depend on uncertain future events
Conventional costs	costs typically recognized in capital budgeting exercises such as raw materials, supplies, and equipment

Cost allocation	the procedures and systems for identifying, measuring, and assigning costs to processes, products, or other cost centers for internal management purposes
Discount rate	the percentage return that represents a firm's opportunity cost of capital, the highest return that the firm could earn with another investment; a means of adjusting future cash flows for time and risk so that they are comparable to current cash flows
Discounted payback period	the amount of time required for an investment to generate sufficient cash flow, on a discounted basis, to cover its initial capital outlay; the time at which the net present value (NPV) of an investment equals zero
Environmental liabilities	a legal obligation for a future expenditure due to the past or ongoing manufacture, use, release, or threatened release of a particular substance, or other activities that adversely affect the environment[13]
External costs	costs that result from the effects of production and consumption activities not directly reflected in the market[14] or not borne by the responsible party; a synonym for societal costs (also termed externalities)
Hidden costs	environmental costs that are not apparent to managers (e.g., regulatory compliance, waste management, or remediation costs) because they are recorded in overhead accounts, or are not accounted for because they will or may occur in the future
Internal costs	costs that are priced by the market or some other pricing mechanism that accrue directly to a specific entity; e.g., a business or individual; (also termed private costs)
Internal rate of return (IRR)	the discount rate at which the net present value (NPV) of a stream of cash flows is equal to zero; IRR is typically compared to a company's desired rate of return on an investment
Less tangible costs	costs that are difficult to predict or quantify, such as the costs of lost business resulting from tarnished corporate image, diminished employee moral, or unrealized "green market" share (also termed "image costs")

[13] Taken from US EPA's *Valuing Potential Environmental Liabilities for Managerial Decision-Making: A Review of Available Techniques* (EPA 742-R-96-003), 1996.

[14] Taken from Pindyck, Robert S. & Daniel L. Rubinfeld, *Microeconomics*. Second Edition. New York: Macmillan Publishing Company, 1992.

Life-cycle assessment	a holistic approach to identifying the environmental consequences of a product, process, or activity through its entire life-cycle; i.e., from raw material acquisition through ultimate disposal
Materials accounting	an accounting system for the flow, generation, consumption, and accumulation of materials (collectively, the throughput) in a facility or process in order to identify and characterize materials use and waste
Net present value (NPV)	the present value (i.e. the value in current period dollars) of a stream of cash flows; a stream of cash flows is profitable if its NPV is greater than zero
Operating costs	costs incurred during the operating lives of processes, products, systems, and facilities, as opposed to one-time up-front costs (e.g., investment costs) and back-end costs (e.g., shutdown and remediation costs)
Overhead	a set of costs aggregated into a central account but not directly assigned to a process, product, facility, or other cost center; overhead costs later may be assigned to cost centers using some allocation basis such as labor hours, production volume, materials use, etc.
Payback period	the amount of time required for an investment to generate sufficient cash flow to cover its initial capital outlay; payback is calculated as the investment amount divided by the annual cash flow
Environmental regulatory costs	costs incurred to comply with federal, state, or local environmental laws (also termed **compliance costs**)
Total Cost Assessment	the process of integrating all relevant and significant internal costs, including less tangible costs, into the financial evaluation of environmental projects and programs; the process includes appropriate cost allocation, project time horizons, and profitability indicators
Up-front costs	one-time costs incurred prior to the operation of a process, system, or facility (e.g., siting, supplier qualification, evaluation of P2 options)

Note: This Glossary was adapted from the US EPA's *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms.*

Appendix B – FEEDBACK AND INFORMATION FORM

Did You Find this Document Useful?
Why or Why Not?
Let Us Know!

Name:

Position & Firm:

Address:

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Email:

How did you hear about this document?

Did you have any knowledge of / experience with EA before you read the document? If yes, please elaborate.

Did the document help you understand EA concepts?

Do you think you might try to use EA in your business (if you haven't already)?

If so, do you feel you still need more guidance? (please be specific)

What aspects of the document did you find particularly valuable?

What aspects would you improve and how?

Do you know of any other case studies or have any EA experiences that we could include in our Internet database?

Business Decision:

Business Benefits:

Company Profile

Location:

Size:

Annual Revenues:

Business:

Why was Project Performed?:

Project Description:

Analysis Description:

Financial Parameters:

Financial Results:

Contact:

Decision and Institutional Changes Made:

Source(s):

Do you have any other comments or observations?

Please return this form or direct any questions to:

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