United States Environmental Protection Agency
Office of Pollution Prevention and Toxics (MC-7409) Washington, DC 20460
EPA 742-R-00-002
April 2000

Enhancing Supply Chain Performance with Environmental Cost Information:

Examples from Commonwealth Edison, Andersen Corporation, and Ashland Chemical

Environmental Accounting Project
USEPA

ACKNOWLEDGMENTS

This document was prepared under Contract No. 68-D5-0008 for the U.S. Environmental Protection Agency (EPA). Staff from the Battelle Memorial Institute and EPA assisted in this project. At EPA, Susan Meisner and John Nanartowicz were Contract Officers, Sineta Wooten was Project Officer, and Susan McLaughlin and Kristin Pierre were the Work Assignment Managers. At Battelle, Joseph Fiksel was Project Manager, and Joyce Smith Cooper and Jeff McDaniel were technical contributors and the report's primary authors.

Each of three case study companies volunteered generous amounts of information to this report as well as considerable hours for in-depth reviews. At Commonwealth Edison, Tom Tramm led the effort to provide detailed insights into the company's life cycle costing practices. At Andersen Corporation, Dale Olson provided technical contributions and coordinated the Andersen in-house reviews. Thanks also go to Andersen's Dan Michaelis, Tim Foster, Kirk Hogberg, and Sharon King for their support and encouragement of this project. At Ashland Chemical, John Harris led the effort and was supported by Kent Carleton, Fred Froehlich, and David Vogel (from The Gauntlett Group, LLC).

EPA is indebted to all of the individuals whose reviews of working version of this document were essential to developing and enhancing the value of this report. Those individuals are:

Allen Aspengren
3M Corporation

William Bilkovich
Environmental Quality Consultants

Scott Clay
Pacific Gas and Electric

Mary Ann Curran
U.S. Environmental Protection Agency

John Ehrenfeld
Massachusetts Institute of Technology

Holly Elwood
U.S. Environmental Protection Agency

James Fava
Five Winds International

Matt Gillen
U.S. Environmental Protection Agency

Robert Handfield
North Carolina State University

Miriam Heller
University of Houston

Edward Huller
The Dow Chemical Company

David Kling
U.S. Environmental Protection Agency

Patricia Layton
American Forest & Paper Association

Clare Lindsay
U.S. Environmental Protection Agency

Mary McLearn
Electric Power Research Institute

Lisa Murphy
Louisiana State University

Thomas Murray
U.S. Environmental Protection Agency

Janet Ranganathan
World Resources Institute

Naomi Soderstrom
University of Colorado at Denver

Leanne Viera
IBM Corporation, Supply Chain Optimization

Ron Spencer
Dell Computers

Steve Walton
Emory University

Robert Stephens
General Motors Corporation

These case studies are descriptions of initiatives, business practices, and decision-making approaches at Commonwealth Edison (ComEd), Andersen Corporation (Andersen), and Ashland Specialty Chemical Company (Ashland). Therefore, the concepts, terms, and approaches presented in this document represent those used by participating companies, and do not necessarily reflect the position or the views of the U.S. Environmental Protection Agency nor those of individual reviewers.

Executive Summary

Companies' information systems typically hide from decision-makers the costs and benefits related to their environmental, health, and safety (EH&S) performance. Such costs may include not only those costs historically associated with EH&S, but also costs associated with material usage, labor, and capital resources. Heightened recognition of these costs through *environmental managerial accounting* approaches these costs often reveals cost-effective opportunities to prevent pollution and eliminate wastes, and encourages business decisions that are both financially superior and beneficial to the environment.

Supply chain management is a particularly promising area for the application of environmental managerial accounting techniques. Many firms already pursue strategies that emphasize eco-efficiency, i.e., improving material utilization per unit of production. By expanding those efforts to include purchasing, inventory management, materials handling, disposition and logistics, companies can further improve environmental and cost performance. Environmental managerial accounting methods enable them to identify and quantify the most viable opportunities.

This collection of case studies illustrates how supply chain management practices can be improved by determining the financial impact of business activities that have an impact on a company's environmental performance. Moreover, this report shows how environmental managerial accounting approaches can be integrated into ongoing business processes. The report includes case studies of multi-disciplinary processes at three companies: Commonwealth Edison, Andersen Corporation, and Ashland Chemical Company. While the approaches vary among these companies, each one provides valuable lessons for other companies. Brief summaries of each case study are provided below.

Commonwealth Edison

The experience of Commonwealth Edison (ComEd), a large Chicago-based electric utility company with annual revenues of approximately $7 billion, demonstrates that electric utilities and other companies can successfully and substantially reduce their costs and environmental burdens with innovative accounting practices. In 1993, ComEd began to recognize that the total cost of managing materials and equipment was much more than the initial acquisition cost. In particular, company managers realized that the costs related to environmental management were often overlooked. This acknowledgment led to ComEd's first phase of life cycle management activities, which enabled them to minimize the chemical inventories at generating stations. These reductions and other early successes prompted ComEd to launch a formal Life Cycle Management (LCM) initiative in 1995. Since then a small, dedicated LCM staff has formed effective partnerships with ComEd operating divisions to systematically assess life cycle costs and benefits.

ComEd's LCM initiative has reduced waste volume while providing over $50 million in financial benefits. While these gains include improvements in supply chain management, facility management, and other business processes, this case study focuses on the supply chain activities.

Andersen Corporation

The activities of Andersen Corporation illustrate how a company can improve its financial and environmental performance by using environmental managerial accounting information in supply chain management decisions. As the largest manufacturer of wood windows and patio doors in North America with annual revenues of approximately $1 billion, this company achieved substantial financial and environmental benefits when it began incorporating environmental considerations into its purchasing, materials handling, inventory, and disposition decisions.

In the late 1980s, executives at Andersen released a directive to their staff to reduce emission levels of toxic chemicals. In response to the directive, Andersen managers formed a Corporate Pollution Prevention Team whose mission was to eliminate the use, release, and transfer of hazardous chemicals. This multi-disciplinary team conducted a waste accounting project, developed waste reduction goals, and justified waste reduction projects by developing several business cases that quantified environmental and other cost savings. For example, the team justified the purchase of an improved system for mixing paints at point-of-use based on the savings from improved material usage rates and reduced waste.

Based on their initial success, company managers recognized that a more systematic implementation of environmental accounting techniques would improve their ability to make strong business cases for a wide range of projects. Accordingly, they developed procedures for environmental cost assessments for a number of supply chain management activities. The process leads to more comprehensive and lucid business cases, including detailed Internal Rate of Return (IRR) schedules that incorporate savings from increased material efficiency and reduced waste streams.

Ashland Chemical

While a number of companies have adopted environmental accounting practices, relatively few have fully integrated these activities into their established cost accounting methods. The Electronic Chemicals Division of Ashland Specialty Chemical Company achieved this integration during a manufacturing cost analysis in 1999. The corporate auditing team and an external consultant led a process of identifying and quantifying a number of cost reduction opportunities. Several of these opportunities supported the company’s overall goal of using materials more efficiently and minimizing waste.

This case study describes how the company integrated its Manufacturing Cost Analysis and Environmental Health & Safety (EH&S) Cost Study and provides specific tools that can help companies realize similar objectives. These tools include a detailed list of environmental activities, a representative list of interviewees, and a time allocation worksheet for capturing hidden environmental, health, and safety (EH&S) costs. The integration effort uncovered at least one sizeable cost reduction opportunity and has led the company to make EH&S cost considerations an established part of its broader cost audits.

TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

U.S. EPA's Environmental Accounting Project strives to help companies incorporate environmental, health, and safety (EH&S) costs and benefits into decision-making. Such costs may include not only those costs historically associated with EH&S, but also costs associated with material usage, labor, and capital resources. Heightened recognition of these costs often reveals cost-effective opportunities to prevent pollution and eliminate wastes, and encourages business decisions that are both financially superior and beneficial to the environment. The Environmental Accounting Project (EA Project) offers numerous educational resources that demonstrate successful environmental accounting approaches.

This collection of case studies demonstrates the successful application of environmental accounting tools and methods in a key business area—supply chain management. Companies are fundamentally changing how they manage their supply chains. Rigid, arms-length, customer-supplier relationships are giving way to more tightly interconnected linkages. For example, many companies have suppliers automatically replenish their inventory stocks. Other companies outsource product design and development to key suppliers. **Direct interaction with supply chain partners can enable a company to reduce total inventory levels, decrease product obsolescence, lower transaction costs, react more quickly to changes in the market, and respond more promptly to customer requests.**

Essential to supply chain performance is improving the effectiveness of materials management—the set of business processes that support the complete cycle of material flows from purchasing and internal control of production materials, through the planning and control of work-in-process, to the warehousing, shipping, and distribution of finished products. Managers can improve their materials management performance by first understanding how their decisions affect the purchasing, storage, handling, and asset recovery activities throughout their organization. The other component of supply chain management is logistics—the activities to obtain incoming materials and distribute finished products to the proper place, at the desired time, and in the optimal quantities. Companies can greatly improve business performance by working with suppliers, shippers, distributors, and customers to improve their logistics activities.

The environmental impact of supply chain management decisions has received relatively little focus. However, a number of leading U.S. companies have significantly increased their competitiveness by engaging in such environmental performance-enhancing activities as:

- Reducing the obsolescence and waste of maintenance, repair and operating (MRO) materials through enhanced purchasing and inventory management practices.
- Substantially decreasing the costs due to scrap and material losses.
- Lowering the training, material handling, and other expenses for hazardous materials.
- Increasing revenues by converting wastes to by-products.
- Reducing the use of hazardous materials through more timely and accurate materials tracking and reporting systems.

Decreasing the use and waste of solvents, paints, and other chemicals through chemical service partnerships.
Recovering valuable materials and assets with efficient product take back programs.

One reason that supply chain managers do not typically address these environmental concerns is in the structure of traditional cost accounting systems. Raw material and labor costs are directly allocated to the appropriate product or process. In contrast, other costs are accumulated into overhead accounts, which are allocated at a set proportion (e.g., based on the number of units manufactured) to all products, processes, or facilities. This allocation method might be appropriate for many overhead costs, such as rent and upper management salaries. However, this approach can lead to inaccurate costing and ineffective decisions when significant costs—waste disposal, training expenses, environmental permitting fees, and other environmental costs—are not allocated to the responsible products and processes.

Many companies have tackled this issue by using environmental accounting techniques to substantially reduce supply chain costs. With these costing methods, companies can systematically identify environmental costs throughout the supply chain, e.g., costs associated with management of hazardous materials, which typically are not captured through conventional accounting methods. Once the costs (or potential benefits) have been identified, companies can analyze the cost drivers and evaluate alternative cost reduction opportunities.

The three case studies that follow illustrate how supply chain management practices can be improved by determining the financial impact of business activities that have an impact on a company's environmental performance. Moreover, this report shows how environmental managerial accounting approaches can be integrated into ongoing business processes. The report includes case studies of multi-disciplinary processes at three companies: Commonwealth Edison, Andersen Corporation, and Ashland Chemical Company. While the approaches vary among these companies, each one provides valuable lessons for other companies.

ComEd

The experience of Commonwealth Edison (ComEd), a large Chicago-based electric utility company with annual revenues of approximately $7 billion, demonstrates that electric utilities and other companies can successfully and substantially reduce their costs and environmental burdens with innovative accounting practices. In 1993, ComEd began to recognize that the total cost of managing materials and equipment was much more than the initial acquisition cost. In particular, company managers realized that the costs related to environmental management were often overlooked. This acknowledgment led to ComEd's first phase of life cycle management activities, which enabled them to minimize the chemical inventories at generating stations. These reductions and other early successes prompted ComEd to launch a formal Life Cycle Management (LCM) initiative in 1995. Since then a small, dedicated LCM staff has formed effective partnerships with ComEd operating divisions to systematically assess life cycle costs and benefits.

ComEd's LCM initiative has reduced waste volume while providing approximately $50 million in financial benefits. While these gains include improvements in supply chain management, facility management, and other business processes, this case study focuses on the supply chain management activities.

Early Life Cycle Management Activities

In 1993, ComEd began to recognize that the total cost of managing materials and equipment was much more than the initial acquisition cost. In particular, decision-makers did not always consider costs related to environmental management. This realization catalyzed the company's life cycle management efforts. One aspect of this first phase was material accounting: the identification and characterization of waste and by-product streams.

Characterizing Waste and By-Product Streams

To analyze its waste and by-product streams, ComEd participated in the development of the Electric Power Research Institute's (EPRI's)[1] *Accounting Software Applications for Pollution Prevention* (ASAPP). The software helps companies gather and track the quantities and management costs for both waste and by-product streams. ComEd has used ASAPP to ensure rigorous record-keeping and thereby create defensible and auditable environmental materials information.

Using ASAPP, ComEd categorizes wastes and by-products as follows: air emissions, aqueous wastes, chemicals and oils, coal by-products, PCBs, rad-waste, recycling, or refuse. ComEd staff use contracting records and documents to identify the amount of wastes and by-products managed and associated management costs within each category. An excerpt from the ASAPP output from the Crawford fossil generating station is provided in Table 1.

[1] For more information about EPRI, see http://www.epri.com.

Table 1. Example of Material Tracking Results[2]

Waste		Waste Quantity			Management Costs	
Category	Type	Amount	Units	Percentage of Total	Amount	Percentage of Total
Chemicals and Oils	hydrazine/ ammonia/ carbon	85	gallons	5%	$530	10%
	lab packs	49	gallons	3%	$572	10%
	lab waste	14	gallons	1%	$189	3%
	monosodium phosphate	3	gallons	0%	$297	5%
	oil/ fuel/ solvent (non-hazardous)	13	gallons	1%	$2,209	40%
	paints	55	gallons	3%	$89	2%
	parts washer mineral spirits	495	gallons	31%	$702	13%
	rags (solvent content)	55	gallons	3%	$549	10%
	sodium bicarbonate/ ammonium	55	gallons	3%	$122	2%
	soil contaminated oil	5	gallons	3%	$122	2%
	urbine mineral oil	700	gallons	44%	$154	3%
	TOTAL	**1,579**	**gallons**		**$5,535**	
Coal By-Products	commercial bottom ash	264	tons	0%	$763	0%
	commercial fly ash	36,372	tons	60%	$235,703	87%
	waste bottom ash	22,706	tons	38%	$32,810	12%
	waste fly ash	914	tons	2%	$2,968	1%
	TOTAL	**60,256**	**tons**		**$272,244**	
PCBs	bulk liquid	20,620	pounds	100%	$16,800	79%
	bulk solid	45	pounds	0%	$4,526	21%
	TOTAL	**20,665**	**pounds**		**$21,326**	

The ASAPP accounting process was quite revealing. Engineers used the system to identify pollution prevention opportunities at generating stations by focusing on high waste quantities and management costs. Based on the ASAPP data, teams at ComEd facilities investigated a number of waste streams including coal ash, contaminated soil, and waste solvents. The activities of the standing committee formed to evaluate solvent procurement, use, and waste are discussed further in the next section.

While the ASAPP software tool helped identify improvement projects, ComEd realized that its contracting records were not capturing all of the costs associated with waste and by-product activities. As an example, the air emission streams (including carbon monoxide, carbon dioxide, lead, nitric oxides,

[2] Management costs included disposal fees, shipping costs, and personnel expenses that could be readily allocated to the waste streams. For this initial evaluation, ComEd did not calculate other waste-related costs ranging from capital equipment investments to record keeping expenses.

particulates, sulfur dioxide, and volatile organic matter) contained within the ASAPP database are listed with a zero management cost because costs including air treatment equipment purchase, operating, and maintenance costs, emission fees, and record keeping costs were not recorded in the purchase contracting records. By keeping air emissions as a placeholder for these costs within ASAPP, ComEd recognized the omission and plans to expand assessments to consider this wider range of costs.

Improving the Management of Cleaning Solvents

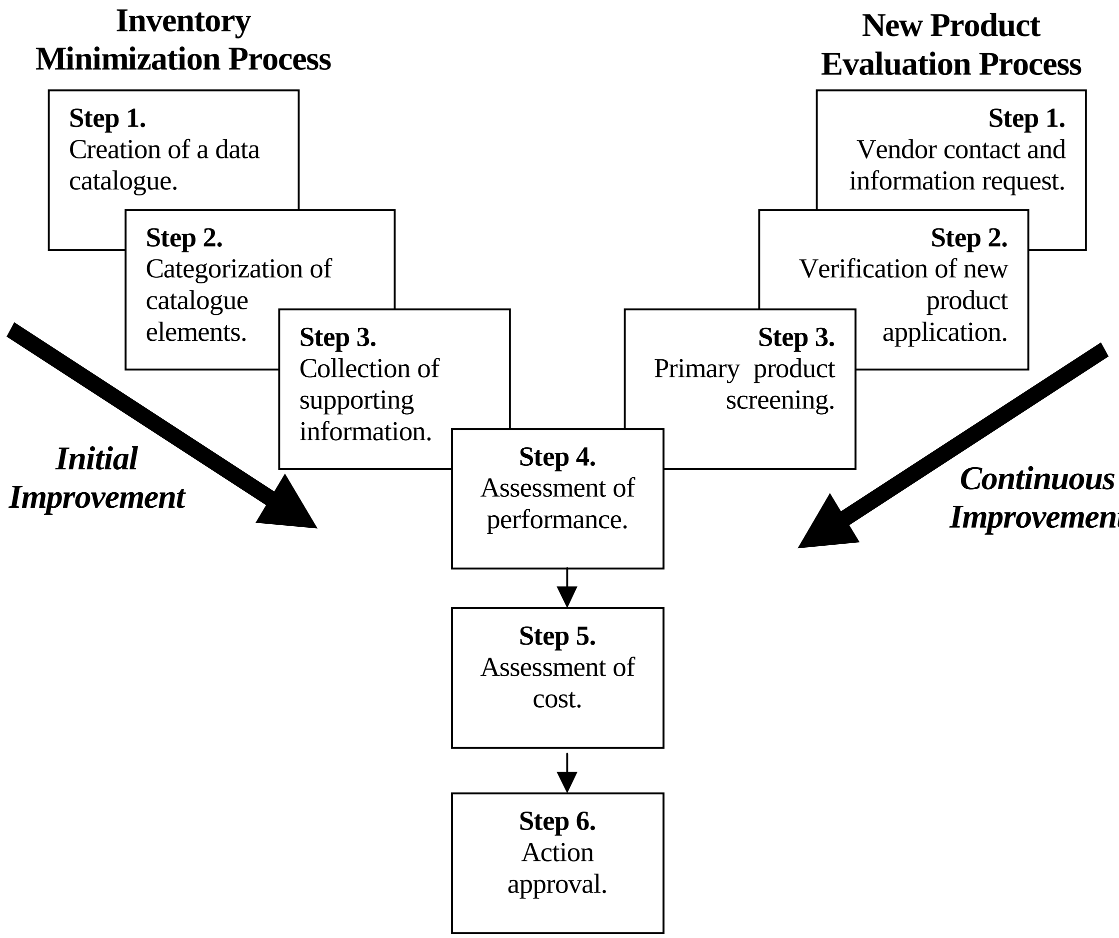
As a result of the ASAPP process, ComEd discovered that one of its largest hazardous waste streams was spent solvents : on average, 60,000 gallons were generated each year. Solvent procurement and use therefore became one of ComEd's first targets for improvement. As shown in Table 2, a standing committee, called the *Solvents Minimization Program,* was formed of representatives from each department that uses solvents or influences that use.

Table 2. Solvent Minimization Program

Business Processes	Committee Representatives
Procurement and Contracting: Vendors are selected, prices are negotiated, and contracts are signed.	• Purchasing
Receiving and Testing: The appropriateness of the place of delivery is checked, the condition upon delivery is checked, and tests are conducted as required by regulatory requirements.	• Systems material analysis
Warehousing and Distribution: Goods are stored and transported throughout the company.	• Stores and inventory management
Operations/ Use and Maintenance: Using the goods to perform the function for which they were procured.	• Operations • Safety/ hygiene • Maintenance
Recovery and Disposition: At disposition, it must be determined what recovery, treatment, disposal, and decommissioning options are available.	• Compliance and environmental services

The committee first established a set of goals and strategies. The goals were to reduce solvent inventories, enhance the safe working environment, minimize waste, and lower cost. The strategies set forth to meet these goals include two systematic assessment processes: the *Inventory Minimization Process* and the *New Product Evaluation Process*. The Inventory Minimization Process provides initial improvement by systematically streamlining what is currently in inventory. The New Product Evaluation Process acts to maintain and improve upon the gains achieved. As illustrated in Figure 1 and described below, both processes include a systematic assessment of performance and cost.

Figure 1. Solvent Reduction Processes



Inventory Minimization Process

The intent of the *Inventory Minimization Process* is to eliminate unneeded or poorly performing solvents from inventories. As listed in Table 3, the process employs six steps:

Table 3. Inventory Minimization Process

Step	Description
1. Create data catalogue	A list of names, identification numbers, and uses for all solvents in inventories is compiled.
2. Categorize elements	Solvents are categorized by use.
3. Collect supporting information	Handling and storage and other regulatory requirements are determined for each solvent.
4. Assess performance	Performance is assessed based on issues relating to cleaning ability, purchasing and supply management, safety and hygiene, analytical requirements, and the environment.
5. Assess cost	Costs are assessed by business process representatives as they impact their own and related activities.
6. Action approval	Recommendations are documented and presented to the committee chair for approval.

For each of these steps, the team members took specific actions. For example, within Step 4, *Assess Performance*, six questions were used to assess a solvent's cleaning ability:

Special Issues and Requirements

Question 1. In your opinion, is this product an acceptable contact cleaner?
Question 2. Does the product leave a residue?
Question 3. Is the product corrosive to metals, vinyl, plastics, or insulation?

Performance Ranking

Question 4. From 1 to 10 (10 being the best), rate how quickly the product evaporates compared to other products you have used.
Question 5. From 1 to 10 (10 being the best), rate how conveniently the product is packaged for your use.
Question 6. From 1 to 10 (10 being the best), rate the product's cleaning abilities.

The first three questions seek information related to special issues or requirements for each solvent. The resulting answers are qualitatively incorporated into the overall inventory assessment.

The latter three questions seek a numeric rating from 1 to 10 (1 being the worst rating, and 10 the best) to be considered in conjunction with the matrix assessment, presented in Table 4. The matrix provides criteria within the four performance areas.

The ratings for these four performance areas are combined using

$$\textbf{Final Product Rating} = \Sigma\, \mathbf{w_i\, r_{ij}}$$

where: w_i = the weighting factor for evaluation area *i*,

r_{ij} = the rating (from 1 to 10) for criteria *j* within evaluation area *i*.

Table 4. Product Evaluation Matrix

worst …... best

Evaluation Area	Criteria	1	2	3	4	5	6	7	8	9	10
Purchasing and Supply Management	cost										
	vendor performance										
	shelf life										
	packaging safety										
	availability of various sizes (unavailability of a variety of sizes should be rated low)										
	storage requirements (special storage requirements should be rated low)										
	difficulty in dispensing (materials that are difficult to dispense should be rated worst)										
Environment	general environmental information from MSDS										
	regulated by RCRA as listed waste										
	regulated by RCRA as a characteristic waste										
	proprietary vs. constituent availability (proprietary should be rated low)										
	regulated by the Clean Water Act										
	listed and/or regulated by SARA										
	regulated by CERCLA										
	spill management and disposal instructions on MSDS										
	disposal required off-site										
Safety and Hygiene	adequate labeling on containers										
	specific health and safety information on MSDS										
	inhalation risk										
	skin absorption risk and irritation										
	ingestion risk										
	fire and explosion risk										
	product stability										
	hazardous decomposition potential										
	incompatibility										
	hazardous polymerization potential										
	venting (engineering) requirements										
	protective equipment requirements										
	storage requirements										
	carcinogenic potential										
	potential acute and/or chronic health hazard										
	reproductive hazard										
Analytical	specification analysis										
	laboratory capability										
	complexity of analysis										
	frequency of testing										
	disposal analysis										

Team members use a software program to calculate the final product rating. This program combines the results of the initial six questions with the detailed evaluation results and creates a historical database of products that have been accepted or rejected. There is also a "flagging" mechanism so that if a product cannot meet a minimum critical standard in any assessment area, or for any reason a product has a special characteristic pertinent to its evaluation, attention can be drawn to the issue.

Solvent Inventory Minimization Pilot Studies

The Solvent Minimization Program committee piloted the *Inventory Minimization Process* on cleaning solvents used at the Will County and Crawford fossil generating stations. Each of the six process steps is described as follows.

Step 1. Creation of Data Catalogue

The Compliance Engineer and the Storekeeper for each station developed a list of 15 on-site solvents and their internal identification numbers. Fifteen cleaning solvents were identified for evaluation.

Step 2. Categorization of Catalogue Elements

First, a survey concerning cleaning solvent use was randomly distributed to "hands-on" users. Committee members then divided the solvents into three categories based on the uses identified within the survey: contact cleaners, electrical component cleaners, and general parts cleaners.

Step 3. Collection of Supporting Information

Associated Material Safety Data Sheets (MSDSs) were collected for all cleaning solvents being evaluated.

Step 4. Assessment of Performance

The 15 cleaning solvents were assessed using the six questions and product evaluation matrix. Subject matter experts such as industrial hygienists, and a cross-section of actual end-users supported the assessment process.

The performance evaluations indicated that the inventory of solvents could be reduced at the Will County and Crawford stations from fifteen to three: two for contact cleaning and another for cleaning electrical components and for general cleaning. Of the two recommended for contact cleaning, one was identified as a superior performer but was also identified as harmful to plastics. Therefore, the second "well performing" contact cleaner would be maintained for applications where plastics are involved.

Step 5. Assessment of Cost

In the pilot on the Will County and Crawford stations, eight cost elements were assessed. However, only three of the cost elements were quantitatively assessed. The quantified costs are presented in Table 5.

Step 6. Action Approval

The results of the performance and cost assessments were combined and the final set of three solvents that were to remain inventory were sent to the committee chair for approval and project initiation.

Table 5. Details of the Pilot Study Cost Assessments

Business Process	Cost Element	Assessment Details
Specification Development	**Solvent specification cost**	**Assessment Type:** Qualitative The comprehensive characterization of the performance, purchasing, environmental, and hygienic implications of solvents focuses decision-making and, as a result, only acceptable solvents are submitted for competitive bidding. This eliminates the time and expense of re-specification.
Procurement	**Purchase cost**	**Assessment Type:** Quantitative **Information Source:** Purchasing records A $117,695 reduction in annual purchasing costs was realized by evaluating the products, recommending the lower cost and better performing products for purchase, and eliminating the rest.
Warehousing	**Carrying cost of inventory**	**Assessment Type:** Quantitative A $15,771 reduction in annual inventory carrying cost associated with inventory reductions was realized.
Warehousing	**Record keeping cost**	**Assessment Type:** Qualitative When solvents are eliminated from purchase, inventory, and use, their associated stores numbers and MSDS maintenance are deleted from record keeping activities, thus saving costs.
Operations/ Use and Maintenance	**Cost of OSHA and EPA citations**	**Assessment Type:** Qualitative **Information Source:** Committee members from Compliance and Environmental Services The likelihood of OSHA and EPA citations and the associated costs are reduced by the elimination of hazardous solvents from purchase, inventory, and use.
Operations/ Use and Maintenance	**Training cost**	**Assessment Type:** Qualitative **Information Source:** Committee members from Compliance and Environmental Services Cost savings result from the elimination of training requirements because employees will not need to be trained on the use and handling of eliminated hazardous solvents.
Operations/ Use and Maintenance	**Cost of solvent misuse**	**Assessment Type:** Qualitative **Information Source:** Committee members from Compliance and Environmental Services Because the correct application for a given product is specified, there is a reduction in the potential for improper solvent use and for unintended exposure of employees to fumes. Thus, potential medical problems and time loss are avoided.
Disposition	**Cost of waste disposal**	**Assessment Type:** Quantitative **Information Source:** Waste management contracts and the ASAPP database The elimination of the generation of chlorinated hazardous waste resulted in a $72,581 reduction in annual waste disposal costs.

New Product Evaluation Process

Once solvent inventories have been minimized through the Inventory Minimization Process, ComEd employs the New Product Evaluation Process to screen solvents being considered for purchase. The purpose of the process is to screen and evaluate new solvents so that only those rated equal to or better than the existing solvent will be purchased and used. In this way, inventory minimization is maintained while the best solvent for the best price is purchased. As shown below, the process employs six steps. Since the final three steps are essentially the same as those for the *Inventory Minimization Process,* only the first three steps are described.

Table 6. New Product Evaluation Process

Step	Description
1. Vendor contact and information request.	After initial contact, the vendor must supply a sample of the product, an MSDS, and a product description. If for some reason the information supplied by a vendor is inadequate, the vendor is allowed to correct inadequacies. If the vendor cannot supply the required information, the product is rejected for use and the evaluation process is discontinued.
2. Verification of new product verification.	There is a possibility that the product already exists as a generic specification or under a trade name. If the product is the same as a product currently on the approved bidder's list, the product will be added to the list. If the product is the same as a product that has previously been rejected, the nature of the rejection is investigated. For example, if the previous product was rejected on the basis of price or packaging, the vendor is afforded the opportunity to correct the inadequacies. If the product was rejected for technical reasons, the product is no longer considered.

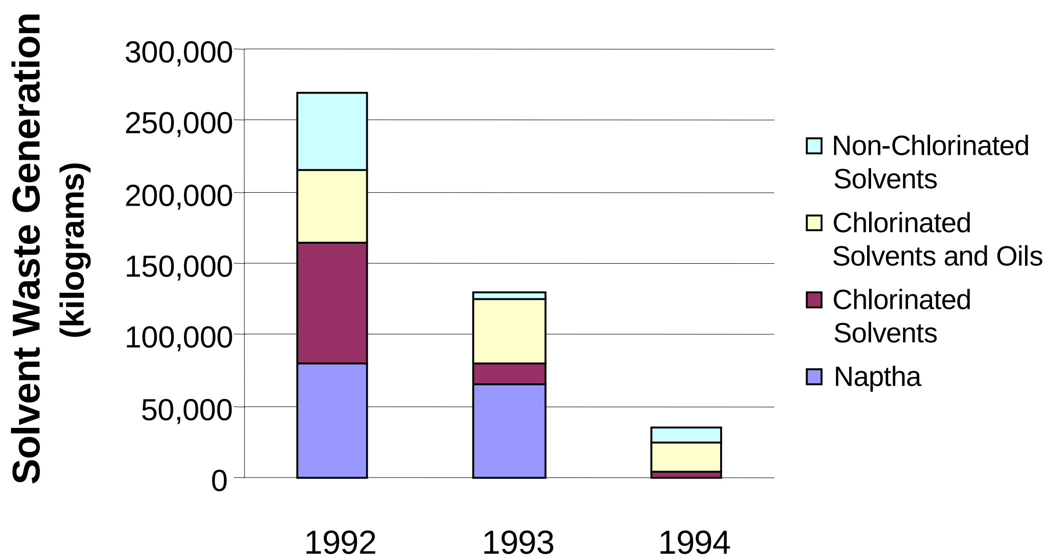
3. Primary product screening.	A primary screening is used to evaluate new product applications or products being evaluated for a new use. The following questions are answered:
	• Does the product meet use specifications?
	• Has adequate information been supplied by the vendor including:
	  • Has the MSDS been supplied?
	  • Is the material a listed waste?
	  • Is the material a characteristic waste?
	  • Are there special handling and/ or storage requirements?
	  • Has the purchasing department qualified the vendor?
	  • Is the material proprietary?

The Solvent Minimization Program standing committee members carried out the Inventory Minimization Process once at each station to reduce inventories. In contrast, the New Product Evaluation Process is utilized by a cross-functional station team on a quarterly basis at a minimum and more frequently if necessary.

Solvent Reduction Results

At the Will County and Crawford stations, the total number of solvents was reduced from fifteen to three. When ComEd extended the process to other stations, they replaced over 100 different cleaning solvents in ComEd's inventories with non-hazardous substitutes. As illustrated in Figure 2, the immediate effect was an 88% reduction of hazardous solvent waste from 1992 to 1994. Because solvents were a major contributor to hazardous waste volumes, a subsequent result was a 66% reduction in ComEd's overall hazardous waste generation during the same period. Additionally, whereas in 1991 thirty-two ComEd stations were large quantity hazardous waste generators, by 1994 this program had reduced this number to thirteen. The program continues to look at other alternatives, such as aqueous cleaners (McCann, 1995).

Figure 2. Hazardous Solvent Waste Generation



The extension to other stations also contributed to substantial cost savings for ComEd. Table 7 lists savings in disposal costs alone (McCann, 1995). Since disposal cost reductions are only a small part of the savings realized, ComEd expanded the effort and created a dedicated Life Cycle Management team that helps each of the business units develop and apply these cost-reduction tools.

Table 7. Disposal Cost Savings from Solvent Minimization Program

Costs	1992	1994
Equipment service	$140,113	$135,836
Chlorinated solvent disposal	$50,095	$1,940
Oil/ chlorinated solvent disposal	$22,194	$9,702
Non-chlorinated solvent disposal	$3,939	$7,232
Annual Total	$216,341	$154,710
Savings		**$61,631**

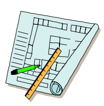
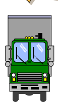
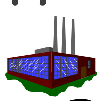
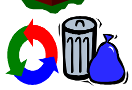
Lessons Learned

Defining the Life Cycle

Among the lessons from the Solvents Minimization Program, ComEd realized that potential improvements in solvent inventories, including cost reductions, could be generalized to all chemical commodities. In fact, ComEd has renamed its Solvent Minimization Program the *Chemical Commodities Minimization Program*. Furthermore, they recognized that improvement efforts could be expanded from chemical commodities to all resources. Within this context, ComEd has defined resources to include all materials (input materials, by-products and wastes) and equipment that are acquired or generated in the course of its operations.

Finally, it was clear that the business, cost, and environmental implications of the decision to acquire each resource initiated a chain of responses throughout ComEd's businesses. For example, a decision to procure a solvent made from a hazardous material was found to affect business processes including specification development, procurement, warehousing, operations, and disposition. To avoid overlooking potentially significant impacts, ComEd defined the life cycle of each resource to include four broad stages:

Table 8. ComEd's Life Cycle Stages

	**Stage 1**	***Design*** involves determining needs and specifying a required resource.
	**Stage 2**	***Acquisition*** involves purchasing (or creating), storing, and transporting the resource.
	**Stage 3**	***Consumption*** involves the actual utilization of the resource.
	**Stage 4**	***Disposition*** involves recovery or disposal of the resource at the end of its useful life.

Encouraging Holistic Decision-Making

While the four-stage life cycle is applicable to all types of decisions, getting decision-makers to explicitly address all four stages as a part of both day-to-day and project-oriented decisions remains a challenge. Even the *Solvent Inventory Reduction* example did not address the entire life cycle. Since the team began the solvent inventory assessments by focusing on currently used solvents, some improvement opportunities associated with the cleaning processes themselves were neglected. If an assessment started with questions directed at, for example, *the need to clean*, the following questions might be asked by the decision-makers:

- Why are parts considered dirty?
- How do parts get dirty?
- Can parts be kept from getting dirty?

- What performance criteria are you trying to enhance by cleaning?
- Are there other ways to attain that performance?
- How do you know when a part is clean?
- What factors influence cleaning frequency?

Confining assessments to the existing set of solvents used by ComEd restricted the range of options examined.

ComEd decision-makers are now encouraged to start by thinking through associated business processes and potential opportunities in each of the four stages of the resource life cycle. Decision-makers may choose to first look at a disposition decision to meet an immediate compliance or pollution prevention need. In a related analysis, the decision-maker may decide to look at decisions made in an earlier stage of the resource life cycle to find a longer-term solution. The expectation is that as decisions are evaluated in earlier stages of the life cycle, opportunities for greater savings will be identified.

As one step to encourage a broader scope in day-to-day and project decision-making, ComEd developed the following ***rules-of-thumb*** directly linked to the stages of the resource life cycle:

- *Design* or choose resources that last longer, are more efficient, or create less waste.
- *Acquire* resources that actually cost less than others do over time.
- *Consume* resources more efficiently.
- *Dispose* of what is left more economically or find other uses for it.

In addition to these rules-of-thumb, station managers are provided with hazardous and solid waste reports and a set of standard metrics to track performance related to the disposition stage of the resource life cycle. These reports provide annual waste generation and cost trends by waste type. Metrics include pounds of waste by facility; dollars spent on waste disposal; pounds of waste per employee; and dollars spent on waste disposal per employee (Hemmady, 1996). Such information provides a means to benchmark immediate needs with the expectation that longer-term issues will be assessed when possible.

Considering a Broader Range of Costs

Through experiences within the Solvent Minimization Program and the use of ASAPP, ComEd identified additional types of costs that could be linked to waste and by-product streams. ComEd discovered that:

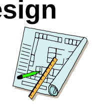
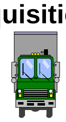
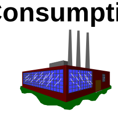
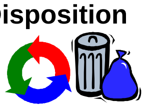
- *Costs and savings can be attributed to a variety of business processes throughout the resource life cycle.* Several of these costs and business processes are listed in Table 9. By considering more business processes, additional cost reduction and revenue opportunities are highlighted. For example, the consideration of disposition can lead to opportunities to obtain revenues through material recovery.
- *Some costs and savings can be linked* ***directly*** *to business processes as captured within existing information systems.* For example,

  - Purchasing costs can be identified from purchasing records, and
  - Waste disposal costs can be identified from waste management contracts and the ASAPP database.
- *Some costs and savings can be linked* ***indirectly*** *to business processes but are not traditionally allocated to a specific resource or business process.* The cost of managing air emissions, reported as "zero" in ASAPP, is one example of such an indirect cost. Costs including air treatment equipment purchase, operating, and maintenance costs, emission fees, and record keeping costs have not been included. Although these costs and savings tend not to be tracked within existing information systems, employees working within each business process can infer them. Once identified, ComEd found these costs and savings relatively easy to qualify but sometimes difficult to quantify.
- *In addition to incurred costs, there are some resources that pose an* ***uncertain*** *risk of future costs.* For example, the true costs of "solvent misuse" and "OSHA and EPA citations" are dependent upon the nature of the misuse or citation.

Finally, ComEd envisioned the *total life cycle cost* of a resource to be the cumulative cost incurred or potentially incurred throughout the resource life cycle. As provided in Table 9, ComEd has linked these costs to the stages of the resource life cycle to provide a starting point for ComEd decision-makers.

Costs or savings not incurred or potentially incurred by ComEd are not included in ComEd's definition of the total resource life cycle cost. For example, the costs associated with property damage and health impacts caused by acid rain as linked to air emissions are not included as management costs.

Table 9. Linking the Life Cycle Stages to Costs [3]

Life Cycle Stages	Direct Costs	Indirect Costs	Uncertain Costs
Definitions	Incurred costs that are traditionally allocated to an activity	Incurred costs that are not traditionally allocated to an activity	Costs that potentially may be incurred in the future
Stage 1: Design 	• Preparing specifications and drawings • Testing • Disposing of testing materials	• Designer training • Record keeping	• Managing spills or accidents in testing • Complying with new regulations
Stage 2: Acquisition 	• Purchasing • Taxes • Shipping • Financing	• Material handling • Storage • Record keeping	• Managing spills or accidents in storage and handling • Disposing and replacing of obsolete resources
Stage 3: Consumption 	• Labor • Equipment maintenance • Incoming inspection	• Delivery to job site • Employee training • Industrial hygiene	• Resource misuse • Managing spills or accidents in use • Packaging disposal • Equipment failure • Occupational exposures and injuries
Stage 4: Disposition 	• Resource storage • Resource recycling • Resource treatment • Resource transport • Resource disposal • Insurance	• Employee training • Waste analysis • Reporting and record keeping	• Complying with new regulations • Legal liabilities • Employee health claims

Keys to LCM Success

In the course of deploying the LCM initiative, ComEd has developed a number of important insights regarding life cycle cost methodology and tool development as well as integration into business decision-making. Many of these insights are transferable to other companies that are striving to improve their supply chain management or other business processes. The six keys to the success of ComEd's LCM initiative are

Applying a systematic approach. By addressing the four life cycle stage and three different cost categories, ComEd was able to identify and then reduce costs that had been traditionally overlooked.

[3]Adapted from ComEd, 1996

Maintaining a dedicated LCM staff drawn from business units. The central LCM staff supports initial decision-making activities, encourages the use of LCM tools and principles in subsequent decisions, and is available for additional support when needed.
Engaging cross-functional decision-making teams. The participation of representatives from a variety of business units brought more information to decision-making, reduced unanticipated implications, and created buy-in among participants and the departments they represent.
Using appropriate decision support tools. Tools such as the ASAPP material tracking software can greatly help educate decision-making groups about the application of life cycle cost methods. For ComEd, the most successful approach has been a facilitated session, in which a knowledgeable and skilled facilitator will guide the decision-makers through the process of identifying cost elements, estimating the range of costs, and evaluating the results. This type of session can dramatically reduce the time required to pilot and demonstrate a new capability.
Beginning with disposition and then working upstream. The original catalyst behind ComEd's LCM initiative was a desire for waste reduction. Successful projects that revealed business benefits in this area provided a basis for moving upstream in the life cycle to address inventory and purchasing issues.
Maximizing investment recovery. One of the best ways to minimize life cycle costs is through the reuse of existing resources. Special attention should be given to alternatives involving idle resources that are already available or can be modified to meet current requirements.

Areas for Improvement

There are, however, some issues are still to be resolved. Potential enhancements to the process could include:

More effectively engaging financial staff. Engineering and operations personnel look to the corporate financial staff for guidance and support in economic analyses, particularly when capital investment is involved. Corporate groups are accustomed to applying powerful analytical tools to strategic financial decisions involving significant uncertainty and risk. These groups are naturally reluctant to endorse broad application of a life cycle cost management methodology that could be applied inconsistently or incorrectly by poorly trained users. On the other hand, there is strong central support for managing resources on the basis of life cycle costs, and the obvious efficiency of distributing powerful decision-making tools is extremely compelling.
Assessing liability costs and other uncertain costs. Considering the full set of uncertain costs provided in Table 9 is an iterative process. For example, evaluating a potential liability could spotlight additional improvement opportunities. As

experience is gained, the value of considering a wider range of costs becomes more apparent.

Applying lessons learned to fuel choice decision-making. Since fuel selection greatly influences a utility company's overall cost structure and environmental profile, utilities might be able to improve their overall performance by applying these environmental accounting tools.

Looking Ahead

Since ComEd began its life cycle management activities, the company has discovered the benefits of broadening the scope of decisions to consider a range of business processes and the full range of direct, indirect, and uncertain costs. The LCM initiative has simultaneously reduced waste volume and provided approximately $50 million in financial benefits. As shown in Table 10, this total includes contributions related to supply chain management, facility modification, and other business processes. The financial benefits represent revenues and savings that definitely will be realized through existing contracts or operating practices. The majority of these contracts are expected to be renewed and therefore will continue to yield financial benefits.

Table 10. Results of ComEd's LCM Initiative

Business Process		Financial Benefit
Supply Chain management (including materials procurement and equipment maintenance)		$25 million
Facility management (including modification and expansion)		$21 million
Other		$4 million
	TOTAL	**$50 million**

ComEd's overall objective is to make life cycle management a fundamental part of their decision-making. Accordingly, the focus of the LCM initiative is shifting from demonstration projects to projects that integrate effective LCM practices into key business processes.

For example, the generation business units are making life cycle cost analysis an element of the project authorization and management processes. Similarly, the transmission and distribution organization is incorporating life cycle thinking into redeveloped material management decision-making processes. In each case, LCM integration is part of overall process and organization changes being undertaken to address other business needs. Active involvement by LCM staff in such business unit organizational change initiatives will enable effective integration.

A number of projects are underway to support the process integration efforts. Software development and targeted training are intended to expand the use of analytical tools for managing life cycle costs. Alignment of organizational goals and incentives continuing remains a challenge. Pilot projects are expected to play a continuing role in demonstrating the value of effective life cycle management in achieving both collective and individual goals. The development of relevant metrics, useful performance reports, and efficient information systems will also be important to the life cycle management strategy.

ANDERSEN CORPORATION

The activities of Andersen Corporation illustrate how a company can improve its financial and environmental performance by using environmental managerial accounting information in supply chain management decisions. As the largest manufacturer of wood windows and patio doors in North America with annual revenues of approximately $1 billion, this company achieved substantial financial and environmental benefits when it began incorporating environmental considerations into its purchasing, materials handling, inventory, and disposition decisions.

In the late 1980s, executives at Andersen released a directive to their staff to reduce emission levels of toxic chemicals. In response to the directive, Andersen managers formed a Corporate Pollution Prevention Team whose mission was to eliminate the use, release, and transfer of hazardous chemicals. This multi-disciplinary team conducted a waste accounting project, developed waste reduction goals, and justified waste reduction projects by developing several business cases that quantified environmental and other cost savings. For example, the team justified the purchase of an improved system for mixing paints at point-of-use based on the savings from improved material usage rates and reduced waste.

Based on their initial success, company managers recognized that a more systematic implementation of environmental accounting techniques would improve their ability to make strong business cases for a wide range of projects. Accordingly, they developed procedures for environmental cost assessments for a number of supply chain management activities. The process leads to more comprehensive and lucid business cases, including detailed IRR schedules that incorporate savings from increased material efficiency and reduced waste streams.

A Call to Action

In the late 1980s, executives at Andersen directed their staff to reduce the emission levels of toxic chemicals. At the time, Andersen regularly used six of seventeen chemicals that are designated by U.S. EPA as priority chemicals. (Andersen emitted or transferred off-site more than 1.1 million pounds of these chemicals in 1988.) In addition to this federal requirement to publicly report these emissions, the state of Minnesota had recently passed a regulation requiring facilities that must report Toxic Release Inventory (TRI) emissions to develop pollution prevention plans. The law defines pollution prevention as "eliminating or reducing at the source the use, generation, or release of toxic pollutants, hazardous substances and hazardous wastes." Facilities must also identify the specific technically and economically practical steps that could be taken to "eliminate or reduce the generation or release of toxic pollutants reported by the facility." Finally, this regulation requires companies to investigate potential upstream process changes that will reduce or eliminate a toxic release.

At the time, Andersen's environmental, health and safety staff were already inundated with regulatory paperwork. Furthermore, Andersen managers anticipated even more stringent environmental regulations on the horizon[4].

Team Formation

For a considerable time, Andersen multi-disciplinary teams have supported technical and business decision-making for a considerable time. Teams are established to achieve specific corporate goals, address operational concerns, and identify and implement improvement projects. Team members can include and engage representatives from any function including plant management, materials management, engineering, finance, purchasing, and research and development.

Andersen managers and staff responded to the call to action by forming the Corporate Pollution Prevention Team. The team's initial mission was to eliminate the use, release, and transfer of TRI chemicals. Eventually, the team added goals to eliminate the use of chemicals identified in EPA's 33/50 program[5] and to reduce the use and emissions of volatile organic compounds (VOCs). While these regulatory concerns were the catalyst, one important result was the improvement of many supply chain activities, including improved material handling processes, increased recovery of wood wastes and other materials, and involvement with key suppliers to eliminate the sources of some emissions. The team was comprised of representatives from technology, business, and engineering groups. They worked closely with other plant personnel and reported periodically to an executive committee.

The team began seeking ways to reduce toxic emissions while simultaneously achieving business and other environmental benefits. Several facets of the company's culture supported a team approach to this challenge, including:

- Use of multi-disciplinary teams to address technical and business issues,
- Use of established financial assessment methodologies that could be easily modified to incorporate environmental costs, and
- To support continuous improvement, communication of results both internally to technical and business personnel and externally to Andersen's customers and communities.

Decision Process

Andersen teams generally follow an established decision-making process. The four basic steps are listed below. The Corporate Pollution Prevention Team's use of this process follows and demonstrates how this process helped Andersen realize both economic and environmental goals.

---

[4] From Adams, L. "Company Closes Window on Emissions: Andersen Corp. has been named a 'Success Story' by the U.S. Environmental Protection Agency after dramatically reducing toxic chemical emissions in its finishing operations." http://www.iswonline.com/archives/wood/fnfjan.html.

[5] The U.S. EPA created the 33/50 program to encourage companies to voluntarily reduce emissions of seventeen priority chemicals, including six targeted by Andersen. The program name is derived from its goals: a 33% reduction in emissions by 1992 and a 50% reduction by 1995, using 1988 emissions as a baseline. Having reached the program goals one year ahead of schedule in 1994, the 33/50 program was successfully concluded.

Identification - Characterize situation, establish goals, and identify technical options
Evaluation - Determine likely results of improvement projects
Justification - Prepare a business case with anticipated costs and benefits
Implementation - Decide, implement project, and communicate results

Identification

The Corporate Pollution Prevention Team began by brainstorming a set of indicators for measuring the types and volumes of wastes generated. These indicators provided a baseline for measuring improvement as shown in Table 11. The Team selected five indicator categories to help them address regulatory requirements and other environmental issues, such as water consumption and solid waste generation. The resulting indicators included both absolute and normalized waste quantities.

Table 11. Andersen's Wastes and Emissions[6,7]

Category	Indicator	Metric	1988 Value
TRI emissions	TRI emissions	Tons	972
	TRI emissions/ units shipped	Pounds	-
33/50 chemical emissions	33/50 emissions	Tons	626
	33/50 emissions/ units shipped	Pounds	-
VOC emissions	VOC emissions	Tons	3,753
	VOC emissions/ units shipped	Pounds	-
Solid waste	Solid waste to landfill	Tons	23,986
	Solid waste to landfill/ units shipped	Pounds	-
Water use	Water used	Gallons	412,800,000
	Gallons of water used/ units shipped		-

The team members obtained the waste and emission data from a variety of sources, especially contracting records and interviews with plant personnel. As the team completed this baseline analysis, they identified the specific processes that contributed to the five waste streams. An example of this breakdown is shown in Table 12. Based on the detailed information, the team prioritized improvement initiatives.

[6] The team calculated the normalized metric values, but for confidentiality reasons, they are not presented in this report.

[7] Please note that the emissions categories overlap. The 33/50 chemicals are an important subset of the TRI chemicals. Also, some of the VOC chemicals are included in the list of TRI chemicals.

Table 12. 1998 VOC Emissions by Process

Process	VOC Emissions (Tons)	(Percent)
Wood Preservative	2,490	67%
Painting	780	21%
Miscellaneous Processes (storage tanks, combustion, and adhesives)	297	8%
Vinyl Processing	186	5%
Total	**3,753**	

This information helped the team focus on the processes that contributed most to the facility's overall pollution levels. As shown above, most of Andersen's VOC emissions came from the wood preservative and painting operations. The team pursued a variety of projects to reduce these wasted materials. Their method (i.e., decision-making steps 2 through 4) can be illustrated by focusing upon one particular project. Therefore, the discussion below willconcentrate on the effort to reduce toxic emissions from their painting operations for Double Hung Windows. The team identified a variety of technical options, but found that a meter-mix system was the only one that could improve product performance and easily integrate with current operations.[8]

The meter-mix paint blending system mixes pigmentation and cure agents at the point-of-use. Since the components are not mixed until just prior to application, only small amounts of paint are wasted and less paint dilution solvents are required. In contrast, the predecessor system mixed paints in lot-size batches. Considerable paint was wasted because the two component paints became too viscous if production delays occurred after the batch mixed.

The improvement goals of the meter-mix system project were to increase process control, and to reduce paint waste and air emissions from the production lines. When the project was proposed, the team estimated that converting the paint lines in one area to the meter-mix system would reduce the company's overall TRI emissions by 1.3% and VOC emissions by 7%.

Evaluation

Next, team members linked cost savings, material savings, and waste reductions to the proposed meter-mix project. This financial and non-financial information was required to develop a solid business case. While the initial objectives were environmentally driven, the team was able to identify a number of business benefits for the meter-mix project as shown in Table 13.

[8] Note that the team did not evaluate more fundamental product design issues such as "the need to paint." Andersen has since recognized that focusing on incremental options limits the magnitude of potential improvements and fails to encourage breakthrough innovations.

Table 13. Cost and Material Reductions of the Meter-Mix Project

Project Goals	Anticipated Material Reductions	Related Cost Reductions
Reduce paint and solvent wastes	• Reduced pigment and solvent use	• Pigment and solvent cost reductions • Waste treatment, transport, and disposal cost reductions
Reduce TRI and VOC emissions	• Reduced TRI and VOC emissions	• Decreased emission fees • Reduced personnel time for record keeping and other environmental activities

Andersen teams had always considered the cost savings from anticipated material reductions in their financial analyses. In contrast, the effort to also quantify the savings associated with decreased waste management expenses was a novel approach. The team decided to include both material and waste costs when calculating the financial benefits of the meter-mix and other improvement projects. While the material-related savings from the meter-mix project were substantial, these potential savings were not recognized prior to the pollution prevention team's effort. Thus, the focus on environmental performance led to some substantial operating benefits. The team's assessment of environmental costs and material reductions for the meter-mix system is shown in Table 14.

Table 14. Improvements from the Meter-Mix Project

Cost Element	Material Reductions	Annual Savings	Percent of Savings
Paint Use and Waste Reductions			
Paint materials, purchase and shipping	3,509 gal./yr.	$110,374/yr.	56.6%
Waste treatment, transport, and disposal		$14,387/yr.	7.4%
VOC emissions and associated fees	15,515 lb./yr.	$162/yr.	0.1%
Dilute Solvent Use and Waste Reductions			
Solvent materials purchase and shipping	8,050 gal./yr.	$58,710/yr.	30.1%
Solvent emissions and fees	53,309 lb./yr.	$560/yr.	0.3%
Flush Solvent Use and Waste Reductions			
Solvent materials purchase and shipping	2,252 gal./yr.	$10,687/yr.	5.5%
Solvent emissions and fees	12,360 lb./yr.	$130/yr.	0.1%
TOTAL ANNUAL SAVINGS		**$195,010/yr.**	

Table 14 links reductions in raw materials and waste materials directly to costs. Material use and waste reductions have been allocated by material type: paint, dilute solvent, and flush solvent. Listing annual material reductions and annual savings in the same row allowed the team to easily view benefits by material type. In the case of paint, the annual use and waste reduction totaled 3,509 gallons. Data for the quantitative assessment were obtained by team members from purchasing and contracting records.

As shown above, the team found that savings related to avoiding material purchases and shipping costs dominated the cost assessment. Furthermore, the team found that although quantifying material reductions associated with emissions provided valuable information to decision-makers, quantifying emission fees contributed little to the overall cost assessment.

However, the team recognized that they had not quantified all of the cost savings that would be realized. Additional savings would include those listed in Table 15. For example, by reducing the need to manage toxic raw materials and wastes, the company decreased its risk of incurring spill cleanup costs, and related legal liabilities. Thus, the team began to demonstrate how environmental costs influenced the company's bottom line.

Table 15. Analysis of Non-Financial Elements

Activity	Non-Financial Assessment
Material handling and storage	The project eliminates the costs associated with handling and storing 3,509 gallons of paint, 8,050 gallons of dilute solvent, and 2,252 gallons of flush solvent.
Waste handling and storage	The project reduces costs associated with handling and storing 3,509 gallons of waste paint and to train employees in associated safe handling procedures.
Analysis, reporting/ record keeping	The project eliminates costs associated with material analysis, handling, and reporting/ record keeping (3,509 gallons of paint, 8,050 gallons of dilute solvent, and 2,252 gallons of flush solvent) and waste (3,509 gallons of waste paint and emission of 81,184 pounds of VOCs) for internal and regulatory audiences.

Justification

After identifying the material and waste reductions, and anticipated cost savings, the team developed a business case for the meter-mix system. Since Andersen teams usually include a payback period and an internal rate of return (IRR) schedule within each business case, the team calculated the values based on the future cost savings shown in Table 16. Several types of cost savings were included in this financial analysis:

- Paint materials — purchasing and shipping costs
- Waste — treatment, transport, and disposal costs
- VOC emissions — associated fees
- Solvent materials — purchasing and shipping costs
- Solvent emissions — material losses and associated fees.

With this cost information, the team demonstrated that the installation of the meter mix system was attractive because the **quantified costs yielded a 18-month payback and 58% internal rate of return.** The payback calculations were relatively straightforward, as shown below.

$$P = I / M$$

Where,

P = Payback period (months)
I = Investment ($)
M = Monthly savings ($/month)

Based on the forecasts in Table 16, the initial investment (I) was $130,100 and the monthly savings (M) during the first two years averaged $7,146. With these values, the payback period can be calculated as 18 months.

Table 16. Meter Mix Internal Rate of Return Schedule

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
INVESTMENT							
Equipment	($115,541)						($115,541)
Installation and other expenses	($14,559)						($14,559)
Total Investment	($130,100)						($130,100)
COSTS							
Additional. costs		($109,355)	($115,302)	($124,941)	($133,161)	($140,438)	($623,197)
Total Costs		($109,355)	($115,302)	($124,941)	($133,161)	($140,438)	($623,197)
SAVINGS							
Paint Use and Waste Reductions							
Paints purchase & shipping		$110,374	$113,685	$117,096	$120,609	$124,227	$585,991
Waste treatment, transport, disposal		$14,387	$15,106	$15,862	$16,655	$17,487	$79,497
VOC emissions & associated fees		$162	$170	$179	$188	$197	$895
Dilute Solvent Use & Waste Reductions							
Solvent purchase & shipping		$58,710	$60,471	$62,285	$64,154	$66,079	$311,699
Solvent emission losses & fees		$560	$588	$617	$648	$681	$3,094
Flush Solvent Use & Waste Reductions							
Solvent purchase & shipping		$10,687	$11,008	$11,338	$11,678	$12,028	$56,739
Solvent emission losses & fees		$130	$137	$143	$150	$158	$718
Total Savings		$195,010	$201,165	$207,520	$214,082	$220,857	$1,038,633
NET BENEFIT	($130,100)	$85,655	$85,863	$82,579	$80,921	$80,419	$415,436

Notes and assumptions:

- "Operating costs" are additional costs required to operate point-of-use system
- 3 % annual increase in material and labor costs
- 5 % annual increase in all other costs, e.g., waste management

The IRR calculations are more complex but fortunately a variety of software packages, including standard spreadsheet packages, can compute these values. The internal rate of return is the interest rate at which the net present value (NPV) of the investment is zero. It takes into consideration the amount and timing of the costs, savings, and revenues of the investment.[9]

[9] Similarly, companies can directly calculate the investment's NPV. The NPV is based on the company's cost of capital and considers the amount and timing of the investment's capital outlays, savings, and revenues. An NPV greater than zero indicates a profitable investment and, as with IRRs, the higher the NPV the better.

The higher the IRR, the better the project. A money-saving project will have a high IRR because it will have a positive value even if the future cost savings are discounted heavily. The IRR calculations are shown below.

$$NPV = 0 = C_0 + \sum C_i / (1 + IRR)^i$$

For the meter mix system,

$$NPV = 0 = -\$130{,}100 + \$85{,}655/(1+IRR) + \$85{,}863/(1+IRR)^2 + \\ \$82{,}579/(1+IRR)^3 + \$80{,}921/(1+IRR)^4 + \$80{,}419/(1+IRR)^5$$

Solving this equation by trial-and-error shows that the IRR is 58%. The trial-and-error approach is somewhat tedious, but again, many software packages can quickly compute IRR values.
These and other analyses demonstrated the operating and environmental benefits of making this investment. As shown, the cost savings linked to the loss of purchased material (paint and solvent) that previously left the facility as waste is the most significant financial benefit.

The team's business case for the meter-mix system included quantitative assessment of material use and waste reductions, assessment of additional environmental costs, and IRR schedule. Thus, the business case demonstrated how the project supported plant and corporate environmental goals.

Implementation

Since the business case demonstrated the financial and environmental merits of the meter mix system, managers approved the project and installed the new system on paint lines in the Double Hung Windows production area.

For the meter mix and other successful projects, the Corporate Pollution Prevention Team supports communication by providing the following documentation prior to, during, and upon completion of project implementation:

> Project Review Sheets summarize input from key plant and corporate personnel prior to final approval. Statements from plant managers (including time study comments), environmental (including permit status), electrical, machine design engineers, and facility engineers, maintenance and health and safety managers are included.
> Plant Communications reports document project status and results, and communicate them throughout the organization. Project information include the date of completion, project scope, benefits gained, and the names of project leaders. In addition, the team presents a summary of results at an annual meeting for the operating managers and support staff.

In addition to internal communications, Andersen externally publicizes their waste reduction successes through promotional documentation focusing on environmental protection, as well as by highlighting environmental awards, such as their recent Minnesota Governors Award.[10]

Supply Chain Improvements

Based on the success of the meter mix system and other initial activities, the Corporate Pollution Prevention Team targeted several other areas to reduce toxic chemicals and other wastes. These target areas included several supply chain activities, such as paint hook cleaning operations, paint operations, and glass handling.

Reusable Packaging for Glass

Two of Andersen's significant solid waste streams were cardboard packaging and broken glass. Packaging was highlighted as a high volume waste during the initial analyses of the company's solid waste stream. While the glass waste stream was not as large, the subsequent review of associated costs showed that the material losses were quite costly. Additionally, a number of employee injuries were caused by handling broken glass.

The team had determined that the corrugated shipping boxes for incoming glass and accompanying broken glass were significant solid waste streams, so the team began working with its glass suppliers to decrease these volumes. One of the suppliers was able to develop a plastic, reusable packaging system that:

- Essentially eliminated the corrugated waste stream since the plastic containers are collapsed after usage and returned to the supplier.
- Greatly reduced the glass breakage that occurred during the receiving and inventory steps because the reusable containers were more protective.
- Reduced Andersen's overall costs by $127,000. Most of these savings resulted from the decreased breakage.

[10]Andersen's 1997 award information can be viewed at http://www.moea.state.mn.us/berc/govaward97.cfm.

Paint Formulation

While the meter-mix project was primarily an internal project and did not address fundamental design issues, the Corporate Pollution Prevention Team was heavily involved with suppliers during other projects to reduce emissions from the painting processes.[11,12] For example, Andersen purchasing agents met with their several paint suppliers and requested that they eliminate the TRI chemicals from their paint formulations. To provide an incentive for the suppliers, Andersen committed to work closely with them during the evaluation process and to purchase a substantial portion of their paint from any suppliers that achieved the goal. Over a three-year period, the suppliers developed new paints. The new formulation had to perform as well as, or better, than the original chemistry. In 1995, non-TRI solvents, including methyl amyl ketone (MAK), n-butyl acetate, and isobutyl acetate, were adopted and helped the company reduce its TRI emissions waste stream.

Paint Hook Cleaning

At Andersen, wood and fiberglass window and door parts were painted using a vertical paint application system. The components were hung from paint hooks and hangers. When these hooks and hangers became coated with the durable paint and needed cleaning, they were immersed in methylene chloride, a paint remover. After the cured paint softened, the fixtures were rinsed with xylene. This cleaning process released both methylene chloride and xylene and created sludge that had to be treated as hazardous waste.

In the 1980's, Andersen made a number of attempts to replace the paint hook cleaning system, but was not able to find an effective alternative. In 1992, the company tested a paint burn-off, or "oxidation process,"on this material handling system. In this process, fixtures are heated and the cured paint is burnt off resulting in non-hazardous residuals. Since Andersen did not have the type of ovens required for this cleaning process, the company outsourced the operation to a nearby supplier. A financial analysis confirmed that outsourcing the activity would significanlty lower overall costs, including the energy costs at the supplier and the cost of additional purchasing transactions.

The project succeeded and reduced methylene chloride releases from 29,100 pounds in 1988 to 13,000 pounds in 1992. Because of this improvement, Andersen was able to drop methylene chloride from its annual TRI report starting in 1993. Additionally, xylene releases were reduced by approximately 50,000 pounds annual cost savings reached $28,000.

While the financial gains certainly justified the project, the actual impetus was a desire to minimize worker exposure to methylene chloride. A focus on pollution prevention and consideration of EH&S costs (e.g., sludge disposal costs) helped the company achieve this goal.

---

[11] Several companies have engaged their suppliers to reduce the life cycle costs and impacts of their products and services, see US EPA, *The Lean and Green Supply Chain: A Practical Guide for Materials Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance*, January 2000.

[12]From Adams, L. “Company Closes Window on Emissions: Andersen Corp. Has been named a “Success Story” by the U.S. Environmental Protection Agency after dramatically reducing toxic chemical emissions in its finishing operations.” http://www.iswonline.com/archives/wood/fnfjan.html.

Overall Results

Since the Corporate Pollution Prevention Team's inception, Andersen has greatly reduced its toxic emissions, off-site transfers, and other waste streams. As shown in Table 17, improvements ranged from 18% to almost 100% between 1988 and 1996. In fact, Andersen was recently named a 33/50 Program Success Story by the EPA because the company substantially reduced the use of three chemicals - methylene chloride, methyl ethyl ketone and toluene - in its work place.

Table 17. Improvements in Waste Metrics

Category	Indicator	Metric	1988 Value	1996 Value	Change
TRI emissions	TRI emissions	Tons	972	66	93%
	TRI emissions/ units shipped	Pounds	-	-	90%
33/50 Chemical emissions	33/50 emissions	Tons	626	66	89%
	33/50 emissions/ units shipped	Pounds	-	-	99.9%[13]
VOC emissions	VOC emissions	Tons	3,753	1,507	60%
	VOC emissions/ units shipped	Pounds	-	-	46%
Solid waste	Solid waste to landfill	Tons	23,986	725	97%
	Solid waste to landfill/ units shipped	Pounds	-	-	95%
Water use	Water used	Thousands of Gallons	412,800	236,904	43%
	Water used/ units shipped	Gallons	-	-	18%

In addition to these environmental gains, the company has achieved a number of operating improvements. The annual cost savings for the company's improvement projects ranged from $28,000 to $316,000. Finally, Andersen has also realized a number of non-financial benefits. For instance, the primary justification for eliminating the use of methylene chloride in the paint hook cleaning process was to improve worker health by eliminating the potentially hazardous compound.

Lessons Learned

The Corporate Pollution Prevention Team and Technology & Business Development Group identified and implemented a number of projects that reduced waste streams, while providing financial, product, and operating benefits. The initial goal was to reduce emissions, but the teams justified projects with business cases that addressed both environmental and material costs. Through their activities, Andersen has learned the importance of:

- Using multi-disciplinary teams, including supplier organizations, to identify, develop, and assess improvement options;

[13] Although not completely eliminated, emissions have been reduced far below reportable thresholds.

- # Linking environmental costs to categories of materials managed by the plants to help decision-makers develop cost and material assessments;
- # Integrating environmental costs into the company's standard financial assessment method to create compelling business cases;
- # Combining environmental cost information with material use and waste reduction information to link business and environmental goals;
- # Recognizing that environmental accounting tools, especially material tracking activities, can enable environmental improvements and identify opportunities for operating improvements;
- # Realizing that quantifying some environmental cost elements is not always required to justify environmental improvement projects,;and
- # Communicating improvements both within and outside the organization helps maintain the team's momentum and enables others to replicate their success.

While the efforts are certainly commendable, case study reviewers noted that Andersen's program could be enhanced by

- # Focusing on opportunities for substantive innovations in addition to incremental improvements of the current operations.
- # More extensively engaging suppliers and other supply chain partners to understand the life cycle costs of Andersen's products. These interactions support product design and materials management changes that lower overall supply chain costs. Andersen has taken some significant steps in this direction but hopes to extend this practice in the future.
- # Using activity-based costing and other techniques to determine the financial significance of hidden EH&S activities.

Looking Ahead

Andersen is continuing to reduce the environmental impacts associated with its products and operations. Thus far, the team efforts have accomplished impressive environmental gains while simultaneously improving a number of materials management and production operations.

- # The meter-mix project had a 58% IRR and saved $80,000 annually.
- # Other projects by the Corporate Pollution Prevention Team reduced costs by up to $250,000 annually.
- # The net environmental result of these and other projects was a 93% reduction in TRI emissions, and substantial reductions in all major waste streams.

- # Other groups, including the Technology & Business Development Group, have replicated the successful use of environmental accounting techniques. For example, an analysis of the recovery of waste materials and using the resulting Fibrex™ Composite material in one product line demonstrated $250,000+ in annual savings.

The highlighted examples improved the company's material handling, material recovery, and waste disposition process. Further efforts will likely influence other materials management processes, including purchasing and inventory management. As mentioned, Andersen hopes to broader the scope of future projects by including suppliers and designers. The company recognizes that such an integration is an iterative process and will build upon their initial successes.

In a variety of ways, Andersen Windows is improving the environmental performance of its operations and products. Materials tracking and other environmental accounting tools have enabled teams to support this corporate mission. Andersen and many other companies have realized that environmental accounting approaches help them achieve environmental objectives while improving overall operating effectiveness and efficiency.

ASHLAND SPECIALTY CHEMICAL COMPANY

While a number of companies have adopted environmental accounting practices, relatively few have fully integrated these activities with their established cost accounting methods. The Electronic Chemicals Division of Ashland Specialty Chemical Company piloted an Environment, Health and Safety (EH&S) cost evaluation as part of their 1999 manufacturing cost analysis. The corporate financial auditing team and an external consultant led a process of identifying and quantifying a number of cost reduction opportunities. Several of these opportunities supported the company's overall goal of using materials more efficiently and minimizing waste.

This case study describes how the company piloted the integration of its Manufacturing Cost Analysis and EH&S Cost Study and provides specific tools that can help companies realize similar objectives. These tools include a detailed list of environmental activities, a representative list of interviewees, and a time allocation worksheet for capturing hidden EH&S costs. The integration effort uncovered at least one sizeable cost reduction opportunity and has highlighted the benefit of making EH&S cost considerations an established part of its cost audits.

Activity-Based Accounting Approach

As part of Ashland's efforts to continually increase productivity, the company developed a manufacturing cost analysis (MCA) program and applied it within several divisions. The goal of these projects was to identify cost reduction opportunities and begin the implementation process. The four steps of a MCA project are

1. <u>Financial Analysis</u> - Gather financial data and segregate it into cost pools.
2. <u>Cost Model</u> - Determine critical activities and assign costs to products.
3. <u>Breakthrough Team Process</u> - Establish team, identify cost issues, and create plans to achieve efficiencies and realize savings.
4. <u>Final Presentation</u> - Present findings to management team and obtain approval for recommended changes.

MCA project implementation recommendations have included changes in product pricing schedules, process improvements, and product development opportunities. These projects are initially staffed by members of the corporate audit group (2-4) and then augmented by several employees from the sites under evaluation. MCA projects are typically completed in 10-15 weeks.

When Ashland's Electronic Chemicals Division decided to apply the MCA process to two of its production facilities in 1999, the division wanted to deliberately incorporate Environmental, Health and Safety (EH&S) costs. The EH&S Cost Study would be run concurrently with the MCA process. Plant and corporate managers anticipated that EH&S costs would be significant and wanted to not only understand how to reduce these costs but set the stage for achieving a long term goal of permanently integrating EH&S costs into the MCA process. Since expertise in evaluating EH&S costs did not reside in-house, the company retained an external consultant (Mr. David Vogel of The Gauntlett Group, LLC) to help them with this initial EH&S costing effort. Management determined the EH&S Cost Study would be a learning opportunity for their staff and internal EH&S costing experience would be portable to other facilities.

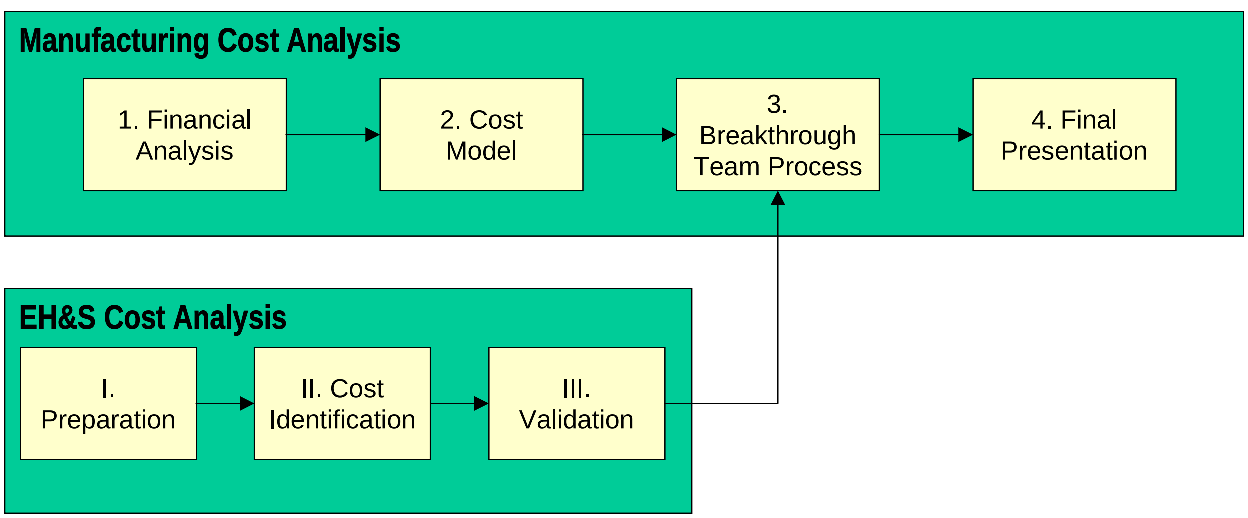
The external consultant focused on helping Ashland during the first half of the Manufacturing Cost Analysis, as shown in Figure 3. Once the EH&S costs had been identified, the Breakthrough team incorporated these costs into the final two steps. Thus, Ashland pursued opportunities to reduce both EH&S costs and a number of other costs during the MCA project.

EH&S Cost Study

The three primary steps that occurred during the Ashland EH&S cost study were

1. Preparation
2. Cost Identification
3. Validation

Figure 3. Point of Introduction of EH&S costs to Ashland MCA Cost Analysis



Preparation began by building an “activity-based” costing model that included some 32 typical EH&S activities that commonly occur at manufacturing sites (see Table 18). Next, Ashland site personnel and the consultant refined this model by adding pertinent activities and deleting irrelevant ones. Then, working with plant management, the consultant identified the individuals most knowledgeable about the agreed-upon EH&S activities and created an interview schedule to be followed during the plant visit.

Table 18. The Gauntlett's Group List of Typical Environmental Activities

Code	Activity Description
01	Training and Preparedness
02	Obtaining Permits
03	Tracking Regulatory Requirements
04	Studies/Modeling
05	Qualifying/Re-qualifying Supplies and/or Materials
06	Record Keeping
07	Developing Environmental Plans, Policies, Procedures, etc.
08	Communicating Environmental Plans, Policies, Procedures, etc. with Organization
09	External Communications, Community Relations, Financial Support to Environmental Groups and Researchers
10	Monitoring and Reporting
11	Inspections and Audits
12	Environmental Insurance and Financial Assistance
13	Protective Equipment
14	Medical Surveillance
15	Spill Response
16	Storm Water Management
17	Re-engineering to Meet Environmental Objective
18	Site Studies
19	Site Preparation
20	Habitat and Wetland Protection
21	Operating Environmental Equipment
22	Maintenance of Environmental Equipment
23	Waste Management - onsite
24	Recycling Materials
25	Handling and Storage of Hazardous Materials
26	Disposing of Non-Hazardous Wastes - offsite
27	Disposing of Hazardous Wastes - offsite
28	Remediation onsite – includes studies, closure, and past-closure care
29	Remediation offsite – includes studies, closure, and past-closure care
30	Fines, taxes, penalties

31	Litigation and Claims – property damage
32	Acquisition/Divestiture Due Diligence

As part of these preparatory activities, the consultant visited an Ashland facility for one day to get an overview of the facility's operations and EH&S activities. This visit and some initial interviews were in preparation for a more intensive visit to review such activities in greater depth and interview key personnel while accumulating related cost information. This subsequent visit was scheduled to coincide with the presence of Ashland's MCA team on the site.

Cost Identification: Identifying Potential Costs with Interviews

During the plant visit, the consultant individually interviewed a number of employees for about 20-30 minutes each to obtain an understanding of the EH&S activities within their sphere of responsibilities and to gather related cost information. The interview process was essential in identifying potentially significant EH&S costs. Results from this process the EH&S Cost Study team to establish priority ranking for potentially large costs that called for subsequent data collection. Costs not deemed significant were eliminated from further data collection efforts.

Employees were asked to describe EH&S activities and estimate the amount of hours they devote to these activities, as well as other resources committed to these activities (e.g., materials and supplies, outside contractor or consulting fees, etc.). Interviews were deliberately informal, to insure that staff did not feel constrained in providing information to the consultant.

Additionally, if a corporate group provides EH&S support to the site, the consultant identified these activities and interviewed appropriate corporate EH&S staff to obtain information about the amount of hours and other resources employed (e.g., consultant fees). In this case study, there were several EH&S activities supported by corporate effort, and such costs are included in this report. A list of the facility and corporate EH&S staff is shown below in Table 19. Identification of both corporate and facility EH&S costs is crucial to obtaining the full costs of EH&S activities within a facility.

Table 19. List of Personnel Interviewed

Facility Personnel	Corporate EH&S Personnel
Acting Plant EH&S Manager (Feb. 1999)	Air Permit Engineer
Chemical Analyst - Rework/Waste Issues	Air Quality Manager
Engineering & Maintenance Manager	Industrial Health & Toxicology Manager
Inventory Specialist	Permit Tracking & Performance Metrics Specialist
Lab Technician	Process Safety Engineer
Plant EH&S Manager	Safety Engineer
Plant Manager	Safety Specialist

Process Engineer	Safety Specialist
Process Engineer	Water & Waste Specialist
Production Manager	
Production Supervisor	
Training Manager	
Warehouse Supervisor	

Validation: Confirming the Interview Findings

The results of the interview process highlighted several potentially significant EH&S costs. That information was used to develop questionnaires seeking additional information on the EH&S activities identified in the interview process. Questionnaires and other methods such as safety training logs, financial records and operational data were used to validate the interview results. These analytical activities provided essential supporting data.

The first tool of the Manufacturing Costs Analysis process was a time allocation worksheet that the MCA team sent to the entire workforce at the plant. As shown in Table 20, exempt (salaried) and non-exempt (hourly) employees were asked to estimate how they spent their time during an average week. Based on input from the EH&S accounting team, the worksheet included three EH&S categories.

Another method was data anlysis. The external consultant and supporting team members reviewed shipping manifests, safety records, training records, and other documents. For example, the training records confirmed that Ashland was investing a substantial amount of employee time into EH&S training. This activity was initially highlighted during the interview process and confirmed with the company's records. In light of the significant training costs, the company will continue to review course content, training methods, and other approaches to maximize effectiveness.

Wherever possible, the significant results from the interviews were investigated and confirmed with one or more record auditing steps. Auditing steps for Ashland, included reviewing training records for all personnel to determine hours actually spent on training and looking at operation logs of the waste water treatment process, identified during the interview process, to calculate actual costs of operation. . This step greatly strengthened the resulting recommendations.

Table 20. Time Allocation Worksheet

Area	Process	Percentage of Monthly Time
Receiving:	- Packaging Supplies, Equipment, Miscellaneous Supplies	
	- Non-Bulk Raw Materials	
	- Bulk Raw Materials	
	- Customer Returns	
Lab	- ACT Lab Activities	
	-WPC Lab Activities	
Processing/Blending	- ACT products	
	- WPC Performance products	
Production/Packaging	- Tank Wagon Fill	
	- Performance/Core Products, Manual	
	- Autoline	
	- Drumline	
	- ACT Manual	
	- Miscellaneous Work Orders (MWOs)	
Bottling	- Production of plastic bottles	
Reclass	- Reclassifying product (different grade, changing lot numbers)	
Dumping/Repouring	- Repouring/consolidating products	
Waste Disposal	- Disposing of Drummed Waste. Neutralization Pit Activities.	
Warehouse	- Warehouse	
Shipping	- Shipping	
Maintenance	- Maintenance	
EH&S Activities	- Meetings/Training/Drills	
	- Special Handling/Putting on Personal Protective Equipment	
	- Other on Job Activities (e.g. - special EH&S procedures, lockout-tagout, record keeping, spill response)	
Administrative	- While Doing Your Job	
	- Training	
	- Meetings	
	- Other (Please specify)	

TOTAL (should equal 100%)

Breakthrough Process

A formal part of Ashland's Manufacturing Cost Analyses is a Breakthrough Process to determine which cost reduction opportunities are most promising. Since both the MCA and the EH&S Costs Analysis addressed the entire set of manufacturing and supply chain activities, the Breakthrough team was able to evaluate several areas, including:

Product Pricing - changing the company's pricing structure to better reflect actual costs
Product Mix - changing the number or types of products offered to customers
Product Development - identifying how to produce and deliver the new products more cost effectively
Resource Efficiency - identifying opportunities to reduce capital investments, especially equipment
Process Efficiency- determining how to increase the efficiency of the current manufacturing and supply chain processes
Productivity Improvements - evaluating alternative manufacturing approaches

As stated earlier, the EH&S Costs Analysis supported the plant's overall cost improvement project. Therefore, the Breakthrough team was able to address EH&S cost reduction opportunities.

The Breakthrough Process began by adding team members who were interested, capable, and able to represent all of the important functions. The final team consisted of 11 individuals from plant management, engineering, production control, financial auditing, product management, and human resources. The team composition was determined during the cost analyses so that team members could be actively involved in the early stages. This early involvement helped speed-up and smooth the transition into the Breakthrough Process.

As soon as the auditing and EH&S teams finalized the cost analyses, the Breakthrough team began its four-week evaluation. They began by reviewing the summary and detailed results of the two studies. As shown in Figures 4 and 5, the team evaluated cost information by both category and activity. Only aggregate levels cost are shown in Figures 4 and 5. Major cost categories were further subdivided to support decision-making.

Figure 4. Total EH&S Costs by Cost Category

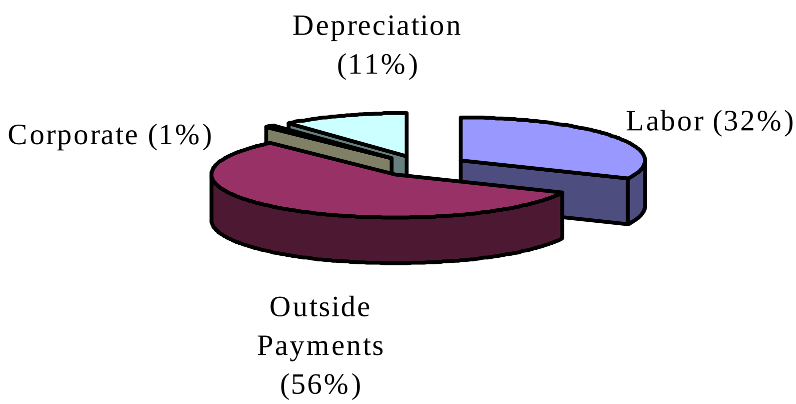
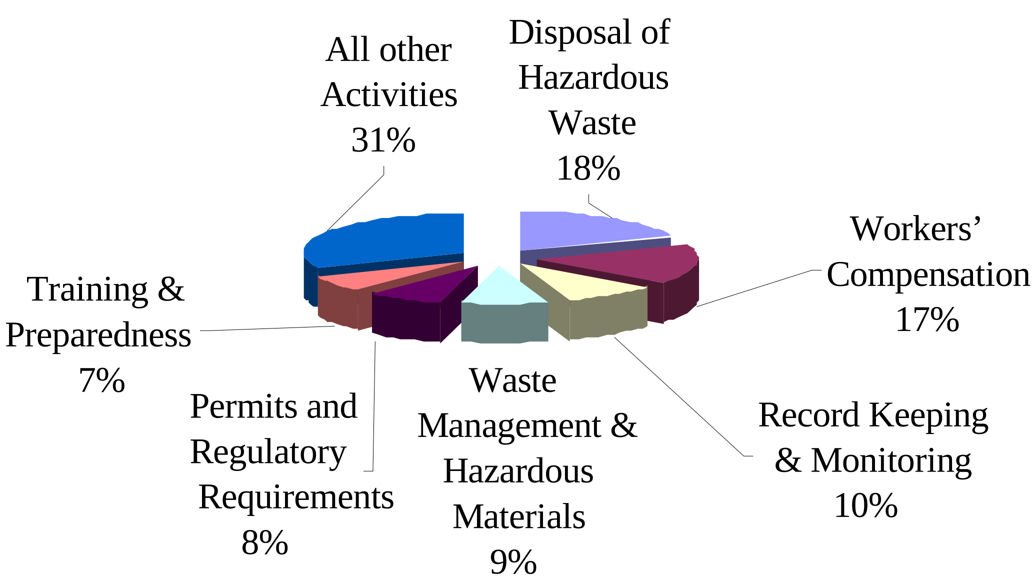


Figure 5. Total EH&S Costs by Activity



The in-depth review of the cost results helped the team identify potential cost reduction opportunities.[14] The team used Pareto charts which show that "usually 80% of the potential improvements can be achieved by pursuing only 20% of the opportunities." The team searched for several indicators of cost reduction possibilities, including

- # The manufacturing areas that had the highest costs (either total or per pound of product).
- # The specific manufacturing activities that had the highest costs (either total or per pound of product).
- # The support areas and activities (e.g., quality assurance laboratories and EH&S activities) that had the highest total costs.
- # The areas and activities that had costs much higher than expected by manufacturing and supply chain personnel (the "surprise factor").
- # The products that had the highest costs.

Armed with this information, the team evaluated each of the high priority opportunities. The goal was to determine which specific improvements could be implemented and estimate the likely financial return from each improvement. The Breakthrough team used a variety of approaches to complete this step, including reviewing historical data, benchmarking their plant's performance to other Ashland facilities, interviewing customers and suppliers to understand which changes were feasible, and engaging plant personnel in problem solving sessions.

Final Presentation

The Breakthrough step was followed by a presentation to the division's senior management group. The Breakthrough team reviewed their activities and presented eight cost reduction recommendations that would yield a significant annual savings. In addition to these short term recommendations, the team proposed evaluating a number of other longer-term opportunities that appeared promising but could not be fully evaluated during the four-week time period.

Several of the cost reduction plans supported Ashland's goal of improving its overall environmental performance, and one of them was particularly noteworthy. Based on the results of the EH&S Cost Study, the team recommended changing the plant's wastewater and by-product neutralization process. The existing process required a substantial amount of personnel to monitor, record, and adjust the operation. The external consultant and internal personnel realized during the EH&S cost study that the plant already had most of the information and analytical systems necessary to automate the process and

[14] During the interviewing and other cost analysis steps, the teams had already developed several promising ideas. However, the Breakthrough team reviewed the results of the cost analysis to confirm those ideas. The team also identified a number of opportunities that had been overlooked previously.

greatly reduce personnel expenses. The Breakthrough team confirmed those findings and estimated that the annual cost savings would be sizeable.

For each of the recommended changes, the team provided the following information:

- Description of the required change
- Savings Potential (annual cost reduction)
- Estimated Investment
- Process Owner (specific individuals responsible for implementing the change)
- Target Completion Date (between one and six months)

The team received approval on all of their recommendations and began the implementation phase. Implementation was only beginning at the time this report was written, so results are not included here. However, Ashland's focus on quick, effective implementation was demonstrated by the senior management group's request for a follow-up meeting four months after the Breakthrough recommendations. At that time, the team will present the implementation progress and evaluations of the longer-term opportunities.

Lessons Learned

The Electronic Chemicals Division of Ashland Specialty Chemical Company was able to incorporate a full set of EH&S costs into its recently completed Manufacturing Cost Analysis. After an external consultant helped Ashland identify and analyze the EH&S costs, the improvement opportunities were judged along with a variety of others. While only one of the EH&S opportunities was included in the initial set of eight high-priority projects, several others are still being evaluated. Additionally, the company has taken some steps to begin consistently incorporating EH&S costs into a variety of business decisions. Some of the lessons from this effort include:

- Work with a corporate group to understand their current approach so that EH&S considerations can be addressed with minimal changes to the existing process
- Leverage an external consultant to quickly develop EH&S cost accounting capabilities
- Use a series of interviews with individuals from both the manufacturing facility and the corporate EH&S group to identify the major cost issues
- Confirm the initial set of cost issues with by reviewing a variety of records, including training records, shipping manifests, and production reports
- Initiate the implementation phase by obtaining senior management approval.

Looking Ahead

Both the Manufacturing Cost Analyses and EH&S Cost Study are relatively new to Ashland Specialty Chemical Company. Each of the company's business divisions has the authority to choose which, if either, improvement process will be deployed in their business unit. While the corporate organization funded the development of these capabilities, continued use will require funding from the business units. In other words, the longevity of these processes depends upon the team members' abilities to consistently reveal and implement cost reduction opportunities.

This initial effort to integrate EH&S considerations into the company's broader cost reduction program proved successful and will continue. The integration revealed at least one significant cost reduction opportunity and helped the audit team members better understand the plant's operations. As a demonstration of the audit team's satisfaction with the results, the team has added an EH&S module to the cost model that they will use in future projects.

The EH&S cost studies are one part of the company's program to increase the awareness of EH&S considerations throughout the company and to integrate them into core business decisions. Since the activity-based costing studies reveal hidden and contingent costs that are commonly overlooked during supply chain and other decisions, these studies support the company's dual objectives of improving financial and environmental performance. Ashland's EH&S organization anticipates that the cost studies will support several other initiatives including information systems development, supplier management programs, and chemical management services program.

REFERENCES

In addition to these references, an extensive set of annotated references on environmental accounting and supply chain management is provided in *The Lean and Green Supply Chain* (see below).

Ashland. 1999. "EH&S Costs Baseline Study, Final Draft Report." Internal Documentation, August 20, 1999.

Ashland. "Environmental Cost Accounting Project - Easton, PA; Plant Visit to Overview EH&S Activities." Internal Documentation, February 12, 1999.

Ashland. "Manufacturing Cost Analysis; Easton ECD Plant; Breakthrough Team Action Plan." Internal Documentation. July 8, 1999.

ComEd. "Maximizing Assets, Minimizing Environmental Impacts Through Life Cycle Management." Promotional documentation. 1996.

ComEd. *Opportunity Prioritization System*. Draft Internal Documentation. 1998.

Decision Focus Incorporated (DFI). *Life Cycle Cost Management Case Study of Transformer Disposition.* Prepared for ComEd and the Electric Power Research Institute. 1995.

DelGeorge, Louis. *Fulfilling Environmental Commitment Through Life Cycle Management.* Presented at the POWER-GEN International '96 Conference. 1996.

EPA. *The Lean and Green Supply Chain: A Practical Guide for Materials Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance.* EPA 742-R-99-003. February 2000.

Hall, Tom. "Final Report: Chemical Commodities Minimization Program." Internal memorandum. 1992.

Hemmady, Neena. Pollution Prevention Internship Program, Illinois Environmental Protection Agency and Illinois Institute of Technology. Personal Communication. 1996.

McCann, B.M. "Governor's Pollution Prevention Award Application." April 27, 1995.

McLearn, Mary. Electric Power Research Institute (EPRI). Personal communication. September 4, 1997.

The Gauntlett Group. "List of Typical Environmental Activities." February 1999.

Tramm, Tom. *Managing Life Cycle Costs with CBMS*. Internal Documentation, 1997.