

**The Role of Eco-Efficiency:
Global Challenges and
Opportunities in the 21st Century
Part 2: Industry Case Studies**

*Prepared for the Eco-efficiency Working Group
Sustainability Project
Policy Research Initiative*

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FOREWORD AND ACKNOWLEDGEMENTS

This report is second section of a two-part study undertaken for the interdepartmental Eco-efficiency Working Group as part of the Sustainability Project under the Federal Government Policy Research Initiative. Part 1 of the study is contained in the report entitled *The Role of Eco-Efficiency: Global Challenges and Opportunities in the 21st Century Part 1: Overview and Analysis*. Both reports contain the executive summary. The Eco-efficiency Working Group – led by Natural Resources Canada – comprises a number of Federal Government Departments including Agriculture and Agri-Food Canada, Environment Canada, Finance Canada, Industry Canada and Transport Canada. Kevin Brady, Konrad Saur, Steven Young, Andrea Russell, Curtis Harnanan and Duncan Noble of Five Winds International conducted the study. The study was made possible through the generous cooperation of the participating companies who agreed to be interviewed for this project. The companies and individuals were:

Full Case Studies

Airbus

- Individuals from the Environmental office (Hamburg & Toulouse Plants) and Procurement and Strategy office (Hamburg)

BASF

- Andreas Kicherer - Group Leader of Eco-efficiency, (Ludwigshafen, Germany)
- Daniel Steinmetz - Team Leader, Product Stewardship and Product Safety, Corporate Ecology and Safety
- Indu Namboodiri - Team Member, Product Stewardship

Canfor

- Michael Bradley - Director of Technology, Pulp Marketing Group
- Michael Jordan - Corporate Environmental Manager, Forestry and Environment Department

Compaq

- John Burkitt - Environmental Program Manager
- Larry Stone - Environmental Program Manager
- Walter Rosenberg - Corporate manager EHS&S

DaimlerChrysler

- Individuals from the DfE Team (Mercedes-Benz), department of Environmental Strategy and department of Technology and Research.

Noranda

- Ed Villeneuve - Vice-President of Safety, Health and Environmental Management
- Leonard Surges - Manager, Environment

Shell (Canada)

- Murray Jones – Advisor, Sustainable Development, Corporate Health Safety and Sustainable Development.
- Dave Patterson - Environment/Sustainable Development Co-ordinator Shell Products
- Richard Hart - HSSD Auditor (Operations) and Waste Management Co-ordinator

Shorter Vignettes

3M - Don Coy - Manager, Life Cycle Management

Alcan - Ron Nielsen - Manager, Environmental Affairs and Sustainability
Steven Pomper - Consultant, Climate Change Issues and Life Cycle Studies

Beaver Meadow Farm - Edgar Smith

BP Amoco - From Literature

Kuntz Electroplating Inc. - Brigitte Roth - QMS/EMS Co-ordinator

Saturn - Shari Meghreblian - Manager, Environmental Affairs
Lori Kincaid - Center for Clean Products and Clean Technologies, University of Tennessee

Siemens Canada - A.L.P. Woolley - Corporate Manager, Environmental Health & Safety

Weyerhaeuser Company Limited (Canada) - Jean Pierre Martel - Manager Strategic Issues
John Zagar – Director of Corporate Environmental Services.

Members of the Working Group:

Agriculture and Agri-Food Canada - Terrence McRae

Environment Canada – Duncan Bury

Finance Canada - Krista Campbell

Industry Canada - John Chibuk, Tom Van Camp

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Statistics Canada - Martin Lemire

Transport Canada - Alec Simpson

Executive Summary

Overview

The business climate of the 21st century will be characterized by increasing globalization, revolutions in information technology, rapid process and product innovations and chaotic marketplace demands¹. The marketplace will also be profoundly changed by a predicted population increase of four billion by the year 2040.

All this will take place on a planet that is, in the minds of many decision-makers, already reaching ecological limits in critical areas such as ozone layer depletion, loss of biodiversity, water quality and management, and climate change. The challenge, for industry, governments and individuals will be to ensure that continued economic development and social well-being are compatible with ecological support systems. Achieving this objective requires a dramatic improvement in resource productivity.

These changes are resulting in a rethinking of business strategies to focus on how companies deliver higher value products and services to their customers and how they can increase resource productivity. **This shift will involve the development of materials, products and industrial processes and services that are more eco-efficient.** Eco-efficiency can be broadly defined as the production, delivery, and use of competitively priced goods and services, coupled with the achievement of environmental and social goals¹⁰. Inherent in the concept of eco-efficiency is a strong linkage between environmental performance and shareholder value, a broadening of environmental management to focus on products (as opposed to facilities and substances), and the consideration of the full life cycle or complete product system (raw materials, manufacturing, use, and end-of-life) when identifying improvement opportunities.

The concept of eco-efficiency has been recognized by the government of Canada as a key mechanism for industry to contribute to sustainable development. Recently the House of Commons Standing Committee on Industry noted that “eco-efficiency is an important business practice and management tool, whereby innovations in technology, production, processes, product design and business organization and practices can lead to lower unit costs, improved product quality, lower environmental-related liability, less material usage and less adverse impact on the environment.”¹¹

Study objectives and results

This study is an attempt to provide decision-makers with some insights into the drivers and challenges that organizations face as they shift toward more eco-efficient operations, products and services. The specific study objectives are to:

1. Define eco-efficiency in the context of sustainable development and other emerging environmental management concepts and tools such as life cycle assessment, design for environment and industrial ecology.
2. Identify and explain the primary economic and ecological drivers for eco-efficiency.
3. Provide industry examples of best practices in developing and implementing eco-efficiency. The purpose of the examples will be to clearly demonstrate the environmental and business benefits of eco-efficiency.

¹⁰ Presidents Council on Sustainable Development. Eco-Efficiency Task Force Report. 1996.

¹¹ Productivity and Innovation: A competitive and Prosperous Canada. Report of the Standing Committee on Industry. April 2000.

4. Examine the role that leading national governments are playing in the promotion of eco-efficiency to their industrial sectors.

Companies included in the study were:

Case Studies	Shorter vignettes
BASF	Kuntz Electroplating Inc.
Compaq Computer Corp.	Saturn
DaimlerChrysler (Stuttgart)	3M
Shell Canada	Siemens Canada Limited
Canfor	Weyerhaeuser
Noranda	BPAmoco
Airbus	Beaver Meadow Farms
	Alcan

To understand how eco-efficiency was being perceived and implemented in these organizations senior managers were interviewed and company literature was reviewed. The one exception is the vignette on BPAmoco, which was prepared from publicly available literature on their climate change activities. An analysis of the case study results and discussion of eco-efficiency in relation to competitiveness and innovation is contained in a stand alone report entitled *The Role of Eco-Efficiency: Global Challenges and Opportunities in the 21st Century Part 2: Industry Case Studies*.

The study results indicate that companies who are anticipating and implementing eco-efficiency are doing so to get out in front of market and regulatory trends, to reduce costs, to gain competitive advantage and to ensure long-term profitability and sustainability. In addition, capital markets are increasingly evaluating environmental and sustainable development aspects of firms.

Table ES-1 summarizes the key drivers motivating the companies studied to adopt more eco-efficient practices.

It is important to note that while eco-efficiency generally does not address the full range of social, economic and environmental considerations encompassed by sustainable development, it is an important and necessary step in moving toward more sustainable patterns of production and consumption. The case studies indicate that the practice of eco-efficiency ranges from simple and somewhat standard industrial practices related to improving resource and energy efficiency to highly innovative product and process redesign initiatives, in which ecological or environmental considerations are used as a catalyst for change. The companies examined in the study fell into three categories of environmental management.

Market-Driven. An organization responds not only to regulatory requirements, but also is reactive to its customers' environmental expectations by providing leading product/service and operational performance.

Competitive Advantage. An organization is not only in compliance, but understands its environmental market opportunities and proactively uses that knowledge to create markets where it has sole or leadership market positions.

Sustainable. An organization proactively integrates economic growth, environmental, health, and safety, and social well being into its operations for competitive advantage and long-term viability.

DRIVERS	BASF	Shell	Compaq	D-C	Canfor	Noranda	Airbus
Brand Image	X		X	X	X	X	X
Competitive Advantage	X		X	X	X	X	X
Cost Reduction	X	X	X	X	X	X	X
Customer Relations	X	X	X	X	X	X	X
Employee Relations		X			X	X	X
Regulator Relations						X	
Innovation	X		X	X			X
Legislation	X	X	X	X	X		X
Liability	X	X	X	X	X	X	
Long-term Profitability and Access to Capital	X		X	X	X	X	X
New Markets			X	X		X	
Environmental Performance	X	X	X	X	X	X	X
Standards (e.g. ISO 14001)	X	X	X	X	X		X
Supplier Relations			X	X	X		

Table ES-1: Summary of Eco-efficiency Drivers

In most case the companies studied are striving toward a competitive advantage or sustainability strategy. Eco-efficiency (broadly interpreted) is a key enabling concept and tool for companies to gain competitive advantage. In addition to the overall strategic approach being pursued, the degree of implementation of eco-efficiency within a company is affected by a number of other factors such as: management commitment and support, internal capacity including management systems and tools, financial resources and customer requirements. Key tools being utilized to implement eco-efficiency include:

Management Systems – all the companies studied have adopted environmental management systems. These are either specific environment management systems, integrated environmental, health and safety systems or hybrid systems that incorporate sustainable development or security.

Life Cycle Tools – the majority of the companies are going beyond their own operational boundaries to examine the life cycle aspects of their products and the materials contained in those products. This approach enables better identification of cost-effective environmental improvement opportunities.

Supplier Management Programs – for some companies, particularly manufacturers, working with their suppliers is a key aspect of improving the overall environmental performance of their products as well as managing risks and reducing costs.

Design for Environment – integrating environmental considerations into the product development process. This leads to improved environmental performance, elimination of risk and liability, better choices with respect to selection of materials and processes, and in some cases enhanced quality and performance.

Corporate Environmental Reporting and Communication – in addition to management interviews the companies studied provided numerous publicly available reports on their environmental and sustainable

development activities. A commitment to open communication and transparency was seen by some as a key activity to build relationships with communities and regulators.

Other activities included training and awareness raising, eco-labelling, greenhouse gas trading pilots, forest certification programs, auditing and assurance programs.

Challenges identified by the companies included regulatory pressures, incorporation of eco-efficiency into corporate culture, market volatility, competing priorities, integrating approaches in new business acquisitions, access to capital, markets and people, managing climate change, and environmental expenditures.

Case study summaries

The following tables summarize the findings of the in-depth case studies.

Table ES 4. Company Summary Table: BASF	
Strategy	Market-Driven toward competitive advantage
Policy	Eco-efficiency in support of Sustainable Development - is a core part of the company's business and environmental strategy. BASF is committed to producing more sustainable products, and communicating the company's initiatives and achievements to its customers. An important goal of the company is to combine the strengths of BASF with partners to achieve even greater economic and ecological efficiency in the interests of sustainable development.
Drivers	<ul style="list-style-type: none"> • Competitive Advantage • Customer/market driven • Responsible Care program: CMA requirements, nature of industry
Programs	<ul style="list-style-type: none"> • Product Stewardship Management System • Responsible Care • ISO 14001
Challenges	Integrating eco-efficiency into corporate culture
Tools	<p>Eco-efficiency Analysis tools (LCA, LCI) - In 1996 BASF began using eco-efficiency analysis to examine products and processes. This tool allows the company to seek out products with the best environmental performance at the lowest cost. It can be used to identify product improvements, to compare products to each other or to assess new product designs. The eco-efficiency tool employs the use of algorithms and calculations to compare products and/or position products and set product strategy. The tool requires information on risk, energy, materials, emissions and toxicity. These are used to derive an 'ecological fingerprint'. This ecological data is then combined with economic data to indicate the level of eco-efficiency and conduct comparisons.</p> <p>BASF also uses a number of other tools such as root cause analysis, life cycle costing and life cycle management.</p>

Table ES-3. Company Summary Table: Compaq	
Strategy	Competitive advantage toward sustainability
Policy	Compaq's Environmental Policy prompts proactive behaviour, which extends far beyond environmental regulatory compliance requirements. On a worldwide scale, it encourages Compaq employees to be creative in identifying solutions that enhance the company's drive toward sustainable development.
Drivers	<p>Internal drivers include:</p> <ul style="list-style-type: none"> • reducing non value-added costs • potential co-differentiation • minimizing exposure to risks and liability • brand image. <p>External drivers are:</p> <ul style="list-style-type: none"> • responsibility to customers • community and shareholders • marketing competitive advantage as evident in bid requests • other market demands (e.g., ISO 14000 and eco-labels).
Programs	<p>DfE - focus is on environmental stewardship during every phase of the product life cycle. DfE Guidelines have been developed for use across Compaq product lines on a worldwide scale. DfE Guidelines emphasize several key principles: Energy Conservation, Disassembly, Reuse and Recyclability, Packaging and Upgradability.</p> <p>EMS - a stringent global EMS and evaluation of ISO 14001 based on customer needs and business value. Each site evaluates the decision to pursue certification to ISO 14001 or any other environmental standard. This strategy has resulted in increased ownership, accountability and knowledge of ISO 14001 requirements throughout the corporation.</p> <p>Supply-Chain Management - Compaq has implemented a supplier development process to regulate their supply-chain. The suppliers are given a questionnaire to fill in information about their policy and commitment, compliance history, processes and assessment, their suppliers, CFCs and other hazardous materials, and their waste minimization initiatives. A scoring system is used to evaluate the supplier's performance. Suppliers that score poorly on important environmental criteria may be ruled out as a supplier.</p>
Challenges	<p>Managing environmental aspects of their supply-chain</p> <p>Integrating approaches in new acquisitions</p>
Tools	<p>Environmental Eco-labels: Compaq integrates numerous features into the design and manufacture of its products in an effort to reduce environmental impact over their life cycle. These activities support the attainment of a variety of eco-labels around the world.</p>

Table ES-5. Company Summary Table: DaimlerChrysler	
Strategy	Competitive advantage
Policy	<p>A core element of DaimlerChrysler's corporate strategy that targets long-term value creation is the reduction of negative environmental impacts of its production operations and products.</p> <p>DaimlerChrysler's goal of maximum product quality includes compliance with stringent environmental standards and careful treatment of the natural foundations of life. Accordingly, the company's approach to environmentally acceptable product design requires careful consideration of the entire product life cycle from design, production and use to disposal or recycling.</p>
Drivers	<ul style="list-style-type: none"> • Shareholder value • Stakeholder/Customer Relations • Cost Savings • Brand and public image • Competitive Advantage • Use of Standards (ISO 14001)
Programs	<p>The Design for Environment (DfE) department develops integral vehicle concepts. Its objective is to improve environmental acceptability in an objectively quantifiable way, while at the same time meeting the requirements of the increasing number of customers who pay attention to such environmental aspects as reducing fuel consumption and emissions or using environmentally compatible materials.</p> <p>Life Cycle Management - DaimlerChrysler uses LCM to identify ways to help shed the company's regulatory burden, by looking at all issues simultaneously.</p>
Challenges	<ul style="list-style-type: none"> • Global climate change • Sustainable transport and mobility concepts
Tools	<p>LCA - One important tool in the work of DfE takes the form of Life Cycle Assessments (LCA) of components or entire vehicles. An ecological Life Cycle Assessment takes account of the entire product life cycle – from extraction of the raw materials to production and service life to recycling and disposal</p> <p>LCE – life cycle engineering is a concurrent assessment of environmental, economic and technical performance</p> <p>Life Cycle Costing (LCC) is one of the tools used by the company to detect hidden costs in the areas of EHS and in the recycling costs of substances</p> <p>Performance measures and benchmarking</p>

Table ES-7 Company Summary Table: Shell Inc.	
Strategy	Competitive advantage toward sustainability
Policy	<p>Health Safety and Sustainable Development policy - SD commitment - integrated into business practices –</p> <ul style="list-style-type: none"> • has a systematic approach to health, safety and sustainable development management designed to ensure compliance with the law and to achieve continuous performance improvement, • sets targets for improvement and measures/appraises and reports performance, • requires contractors to manage in accordance with this policy, requires joint ventures under its operational control to apply this policy and uses its influence to promote this policy in its other ventures, and • includes health, safety and sustainable development performance in the appraisal of all staff and rewards accordingly.
Drivers	<ul style="list-style-type: none"> • Previous Environmental issues – e.g. Brent-Spar • Public image • Corporate commitment to SD • Oil prices (falling in mid-1990's) • Global pressure/support for climate change action
Programs	<p>Health, Safety, and Sustainable Development (HSSD) management system – consistent with ISO 14001- includes project assessments done in advance</p> <p>STEPS - Shell Tradable Emission Permit System for GHG</p> <p>Waste Management Contractor Protocol</p> <p>Assurance and audit Processes for the HSSD</p> <p>Remediation and monitoring of service stations</p> <p>Eco-logo lubricants/products</p>
Challenges	<ul style="list-style-type: none"> • Training and awareness in HSSD • Keeping the 'momentum' • Nature of business (fossil fuels) and meeting corporate GHG reduction targets
Tools	<p>Sustainable Development Checklist for Projects – used during the conceptual design phase of any new project or activity. Verification of the assessment must be documented and maintained.</p> <p>Sustainable Development Evaluation Tool – assesses major project's potential impacts, whether negative or positive, on sustainable development.</p> <p>Economic/Environmental Integration Tool – compare different project scenarios and prioritize projects according to the economic and environmental costs and benefits</p> <p>Ecologo – for lubricants</p> <p>Performance Monitoring and Reporting protocols</p>

Table ES-2: Company Summary Table: Canfor	
Strategy	Competitive advantage toward sustainability
Policy	<p>The goals of the Forestry Principles are:</p> <ul style="list-style-type: none"> • Canfor will be a global leader in the profitable production of forest products from sustainably managed forests. • Canfor is committed to the conservation of soil, water and biodiversity and to the maintenance of ecosystem productivity in the forest areas where we operate. • Canfor will use forest ecosystem management that encompasses entire forest landscapes and that forecasts the future condition of forests for 100 years or more. <p>In these principles, Canfor commits to operating according to the triple bottom line of sustainability, using social, economic and environmental values to guide their practices.</p>
Drivers	<ul style="list-style-type: none"> • Public demand for accountability from forestry companies • Customer demand for environmentally superior products • Supplier environmental requirements • Increased efficiency at their operations • Decreased fines / liability • Moving towards sustainable development • Becoming increasingly proactive • More holistic/thorough approach to environmental impacts as a company (due to aspects being determined from the corporate level down to the site level) • Improvements in stakeholder relationships • Better reputation with NGOs • Increased market share
Programs	<ul style="list-style-type: none"> • EMS • Forest Certification
Challenges	The greatest challenge at Canfor in recent years has been the volatility and decline of the forestry market. As a result of stumpage fees and low prices per ton, the company has been challenged in many ways in the last decade.
Tools	<ul style="list-style-type: none"> • LCA • Environmental Performance Declarations

Table ES 6. Company Summary Table: Noranda Inc.	
Strategy	Market-driven toward competitive advantage
Policy	Noranda has an environmental policy, which is aligned with their sustainable development (SD) principles. Their sustainable development principles cover economic, environmental and social aspects of their operations and progress is being tracked through a set of SD indicators. The environmental policy includes a commitment to leadership, operational excellence, product stewardship, open communication and reporting and regular review and auditing of performance.
Drivers	<p>Noranda cited numerous drivers including:</p> <ul style="list-style-type: none"> • Leadership • Brand image of metals in the marketplace • Customer relationships • Trade barriers and business continuity • Reduction of capital and operating costs • Eco-efficiency – e.g. the HP Recycling program - why dig the metals out of the ground again when they can simply be recovered and resold at the same price = more profit and less environmental damage • Employee morale • Relationships with regulators • Facilitating commercial, financial and real estate transactions • More favourable credit terms from financial institutions
Programs	<ul style="list-style-type: none"> • Environment Health and Safety (EHS)/Environmental Management Systems (EMS) • ESH Assurance Program • Responsible Care • Noranda Environmental Awareness Training (NEAT) employee training program • Paste Backfill Tailings Management System • HP recycling initiative
Challenges	<ul style="list-style-type: none"> • Site manager buy-in and competing corporate priorities were two initial challenges that were overcome. Other challenges include: • Volatile nature of commodity markets • Access to capital, markets and people • SO₂ emissions • GHG emissions • Environmental expenditures • Employee buy-in to EHS program
Tools	<ul style="list-style-type: none"> • Developed SD indicators to measure progress toward sustainability. • Life Cycle Inventory

Table ES-8. Company Summary Table: Airbus	
Strategy	Market-driven
Policy	No environmental policy to date - policies of parent companies are used depending on which part of the airplane production process - i.e.: what DaimlerChrysler builds is done according to their policy
Drivers	<ul style="list-style-type: none"> • Efficiency • Cost • Safety • Reliability • Maintenance • Lifetime • Environmental performance
Programs	<p>Environmental management systems – EMAS and ISO 14001 for some sites.</p> <p>DfE as initiated by DaimlerChrysler at manufacturing sites - results of this initiative will be incorporated company wide</p>
Challenges	Regulatory pressure
Tools	<p>Life Cycle Assessment/Management/Costing Reporting (environmental reports, internal reporting) and monthly internal benchmarking</p> <p>Stakeholder communications – frequent interaction with customers to understand needs and priorities</p>

Case study participants who commented on the role of government in promoting eco-efficiency noted government should pursue the following:

- Setting of policies that encourage voluntary initiatives in industry
- Encouraging the use of LCA by industry
- Providing incentives for environmental activities
- Participating in collaborative projects

Apart from the challenges cited by the companies, a detailed barrier analysis was not conducted within this study. However, a recent experts meeting on product-focused tools for sustainable development noted the following barriers to Canadian industry and government moving forward with the development of concepts like eco-efficiency¹²:

- The current tax system is not designed with product and supply chain perspectives in mind and therefore may be providing disincentives for more efficient use of products;
- Unclear definition of the problem/issue and a lack of an overall national strategy;
- Current purchasing practices/codes/attitudes - e.g. against secondary materials, lowest bidder selection, budgeting constraints;
- Unnecessary disincentives toward recycling - e.g., paper work and secondary resources being classified as wastes;

¹² The Ottawa Statement on Product-and Supply Chain-Focused Policies and Tools for Sustainable Development. Environment Canada, 2000. In publication.

- Existing reporting systems do not measure progress towards goals.

In addition, the experts noted that there is a general lack of activity and awareness of product- and supply chain-focused policies and tools within industry, the federal government, the public, and the post-secondary educational system. This finding is confirmed by a recent study prepared for Industry Canada on the status of eco-efficiency in Canada, which found that seven of the eleven industrial sectors examined had minimal awareness of the concept of eco-efficiency¹³. Many of the firms participating in the study were, however, practising a number of the elements of eco-efficiency as well as implementing environmental management systems, adopting life cycle approaches and pursuing supply-chain relationships to identify improvement opportunities. Other key areas noted by the experts meeting where action is required included:

- Capacity building within government and industry;
- The need to build data, information and partnerships to support the adoption of concepts such as eco-efficiency;
- The need for government to develop an overall sustainable development policy framework. This is necessary to understand the importance and priority of promoting concepts such as eco-efficiency and to provide industry with a sense of commitment and direction on behalf of the government.

Study Conclusions

In total 15 companies were examined in this study, seven through the use of in-depth case studies and eight with more focused analysis of specific aspects of their environmental management activities. General findings include:

- While the companies studied can be characterized as pursuing eco-efficiency it is as a more broadly defined concept rather than a precise management approach. In some cases eco-efficiency is a specific tool that is used to improve economic and environmental performance.
- There is a clear linkage between innovation and competitiveness, and eco-efficiency. Companies cited cost avoidance, cost reductions, enhanced brand image, competitive advantage, profitability and innovation as drivers for their environmental and eco-efficiency initiatives.
- A wide variety of tools are in use, but key tools include environmental and integrated management systems, life cycle tools, environmental supply-chain management, design for environment and product stewardship.
- There is a trend toward integrating environmental considerations into core business functions such as strategy, product development, sales and marketing, supply chain management, procurement, capital expenditures and interactions with investors and financial markets.
- There is a role for government in setting the overall policy framework and providing incentives for companies to adopt more eco-efficient practices. It is also important to re-examine existing governmental policies and programs for consistency with eco-efficiency and other advanced environmental management concepts and tools.
- Examples from other jurisdictions indicate that there is a role for government in developing collaborative programs for the development and adoption of eco-efficiency tools and concepts. Although many of these tools have been well developed it should be recognized that the toolbox is still relatively young. Therefore there is a need to refine and more clearly define some of the concepts and tools and ensure that they are applied appropriately.

¹³ Vrooman W. and Beillard C. The Status of eco-efficiency and Indicator Development in Canadian Industry. Prepared for Industry Canada, March 2000.

1. Introduction

This report is Part 2 of a study of eco-efficiency prepared by Five Winds International for the Eco-efficiency Working Group of the Sustainability Project under the Federal Government Policy Research Initiative. The overall study objectives are to:

1. Define eco-efficiency in the context of sustainable development and other emerging environmental management concepts and tools such as life cycle assessment, design for environment and industrial ecology.
2. Identify and explain the primary economic and ecological drivers for eco-efficiency.
3. Provide industry examples of best practices in developing and implementing eco-efficiency. The purpose of the examples will be to clearly demonstrate the environmental and business benefits of eco-efficiency.
4. Examine the role that leading national governments are playing in the promotion of eco-efficiency to their industrial sectors.

This report addresses the third objective of the study and uses case studies to provide decision-makers with some insights into the drivers and challenges that organizations face as they shift toward more eco-efficient operations, products and services. For an overview of the study and an analysis of the results the reader is referred to Part 1 of the report entitled, *The Role of Eco-Efficiency: Global Challenges and Opportunities in the 21st Century Part 1: Overview and Analysis*.

2 Detailed Case Studies

2.1 BASF

“Economic, cultural and ecological requirements necessitate equal and responsible consideration.”

- BASF Responsible Care® 1998 Environment, Safety and Health Report

Corporate Overview

BASF is one of the world's largest chemical groups. In 1999, BASF achieved \$27.5 billion dollars in sales. BASF is a diverse chemical company that operates in more than 39 countries around the globe, with more than 100,000 employees. BASF Corporation, the North American affiliate of the BASF Group, had \$ 7.2 million in sales in 1999 and has approximately 15,000 employees.

BASF's products range from natural gas, oil, petrochemicals and innovative intermediates, plastics, surface coatings, paints, dispersions, fibers, crop protection agents, consumer goods and pharmaceuticals.

BASF's corporate strategy is set forth in its Vision 2010 (Box 1). This corporate strategy represents a joint commitment of BASF AG to sustainable development.

In addition, BASF has long been recognized for making the most of its integrated approach to manufacturing. The Ludwigshafen, Germany site is an example of BASF's worldwide strategy of total integration known as *Verbund*, a German word meaning "linked" or "integrated". It is one of BASF's most important strengths and is a cornerstone of its strategy. BASF prefers highly integrated chemical complexes, which allow the individual facilities to cooperate closely in a single efficient system combining production, energy, and logistics. This has both economic and ecological benefits: raw material resources and energy are utilized efficiently, by-products and wastes are utilized, and transportation is cut to a minimum.

Box 1: BASF's Vision 2010

The company will:

- focus on its customers, build lasting relationships and contribute to their success with innovative solutions.
- operate with all its entrepreneurial resources, including research and development, in its key markets Europe, North America and Asia.
- focus on its technological and regional strengths and take advantage of integrated manufacturing and synergies in research and development.
- balance the range of its activities to reduce the impact of economic cycles.
- further strengthen its raw material position through alliances with strong partners.
- increase the value of its assets to ensure our lasting attractiveness for shareholders and investors.
- align its products and services with the needs and increasing demands of a changing society.
- consider economic, social and ecological requirements in a responsible manner, and engage in frank and constructive dialogue with the public to reconcile business interests with society's demands.
- attract committed and creative employees from diverse backgrounds and countries.
- reduce hierarchy and bureaucracy and communicate openly within its worldwide organization.
- encourage and challenge its employees to take responsibility and entrepreneurial initiative.
- reward employees for the success of the company.

Eco-efficiency is also a core part of the company's vision and environmental strategy. BASF is committed to producing more sustainable products, and communicating the company's initiatives and achievements to its customers and the public. BASF is now utilizing new methods to analyze its product portfolio. BASF together with an external partner developed the instrument of Eco-efficiency Analysis. Eco-efficiency analysis makes it possible in the development and optimization of products and processes to consider economy and ecology together. Eco-efficiency analysis to date, BASF has completed 80 Eco-efficiency studies and is currently doing another 20-25 studies.

Business Context

As an international chemical producer, BASF has to be aware of existing policies, regulations and legislative provisions in the countries that it operates and does business. These regulatory instruments act as barometers in the market in which BASF operates, since they influence quality and types of products and services provided by the company.

The manufacture and production of chemicals presents potential risks to health, safety and environment, and as a result chemical manufacturers are required, by the Chemical Manufacturer's Association (CMA), to implement the Responsible Care[®] management system. Responsible Care[®] ensures worldwide commitment of the chemical industry to continual improvement in all aspects of Health, Safety and Environmental performance.

Petrochemical manufacturers need to be aware of the effects of greenhouse gas emissions on enhanced global warming and climate change. In this arena the petrochemical sector would probably need to address these issues in the context of the national commitment to the Kyoto Protocol in the countries of operation. Companies within this sector would also have to comply with the programs and policies designed to achieve national emissions reduction commitments.

In many jurisdictions the environmental and toxics legislation include a number of pollution prevention measures, including the precautionary principle and the 'polluter pays' principle. Manufacturers and producers of chemical products are regulated by these principles.

Environmental Strategy

BASF corporate guidelines which include commitments to safety, health and the environment as permanent objectives (See Box 2). The purpose behind this was to have a framework for decision-making with respect to aligning economic, social and ecological requirements with company interests, and to facilitate an open and constructive dialogue.

These corporate guidelines are introduced into the company's activities at the policy level of its management system; they are then incorporated into company aims, and translated into programs that are used throughout the organization.

Towards the end of 1995 the company began to develop an eco-efficiency strategy. Eco-efficiency has since become a component in BASF's environmental strategy, using a sophisticated eco-efficiency analysis tool developed specifically for BASF.

Implementation

Management Systems

As a chemical manufacturer, the BASF Group employs the use of Responsible Care[®] as an integral part of its EHS its management systems and is part of the company's eco-efficiency initiatives. Responsible Care[®] is a voluntary commitment on the part of the chemical industry designed to further the acceptance of, trust and confidence in the chemical industry and its products among politicians and the general public. This initiative originated from the Canadian Chemical Producers' Association and is currently used by chemical manufacturers worldwide. This initiative grew out of public concern over the hazards of chemicals and the way the chemical industry was run. Its aim is to dispel that concern by addressing its root cause.

Some of the Responsible Care[®] guiding principles followed by BASF include:

- ensuring that its operations do not present unacceptable risks to its employees, customers, the public or the environment;
- providing relevant information on the hazard of chemicals to its customers, urging them to use and dispose of products in a safe manner, and make such information available to the public on request;
- making Responsible Care[®] an early and integral part of the planning process leading to new products, processes or plants;

Box 2: BASF Corporate Guidelines:

- BASF is committed to Sustainable Development and is guided by it in what the company does.
- An important contribution to Sustainable Development is BASF's participation in the worldwide Responsible Care initiative. This applies to our products and services at all sites.
- Economic considerations do not take priority over safety, health and environmental protection.
- BASF makes products which are safe to manufacture, safe to use and safe to dispose of.
- BASF minimizes impacts on humankind and the environment during production, storage, transportation, marketing and use of its products.
- BASF assists its customers in using its products safely and in an environmentally sound manner.
- BASF provides them with information on the correct handling of its products.
- BASF is committed to making continuous improvements in safety, health and environmental protection. The company does this acting on its own initiative and in consultation with recognized regulatory authorities. BASF takes any action judged to be necessary, whether or not dictated by statutory obligation or official regulations.
- BASF encourages safety, health and environmental awareness among employees.
- BASF regards it as an important corporate duty to advance science and technology in order to improve safety and environmental protection.
- BASF carefully weighs the potential benefits and risks of new discoveries and technologies in dialog with scientists and society before deciding on how to proceed.
- BASF pursues an open dialog with all relevant opinion leaders in society.
- BASF's goals are to promote and strengthen mutual understanding and deepen trust in what the company does.

- using the principle of product stewardship to increase understanding of existing products and their uses and achieve a high level of understanding new products and their potential hazards prior to and throughout commercial development;
- complying with all legal requirements that affect its operations and products;
- being responsive and sensitive to legitimate community concerns;
- working actively with governments and selected organizations to foster equitable and attainable standards.

BASF Corporation is currently developing a Product Stewardship management system that specifically includes a life cycle perspective and eco-efficiency. The use of these approaches is designed to position the Corporation for movement along the continuum from the current proactive phase on to a sustainability strategy. Eco-efficiency is to be used as a strategic product-development tool, which brings EHS issues to planning and marketing. BASF Corporation has EHS management system in place for its operations; however, they are not currently integrated into the Product Stewardship system under development.

A number of groups within BASF Corporation are preparing to become certified to ISO 14001, by the middle of 2000. The main driver behind this move towards ISO 14001 certification is market trends.

Eco-efficiency

BASF has more than 15 years experience with life cycle analysis (LCA) and life cycle inventory studies (LCI). Due to the difficulty in demonstrating the results of these complex studies to business decision-makers, the company developed an eco-efficiency tool as a means of summarizing the results and enhancing strategic decision-making.

During its first year of use, 15-20 studies were completed. To date, 80 studies have been done in Europe with an additional 20-25 in progress. In North America, two have been completed with an additional four studies currently underway and another five to 10 studies planned for 2000.

The company's goal of eco-efficiency is to make a product that has some proven benefit to the end-user, and also has an environmental benefit. The customer is highly involved in these exercises since they provide input data for the analyses, including cost, energy and materials. The results are often discussed with the customer as well as the downstream customers, and are also communicated internally at company meetings, via Innovation Fora, staff newspapers, Internet and Intranet, as well as brochures.

Eco-efficiency is also communicated to employees via training and awareness programs.

The approach to eco-efficiency within BASF has changed from a top-down to a bottom-up product strategy approach, whereas the management strategy differs slightly in the North American companies. BASF follows the approach of finding success stories of how eco-efficiency can be used and shows its value in terms of how it can potentially lead to economic gains and environmental benefits. These stories effect change in the management strategy of companies by encouraging them

to be more successful in the market and aids in convincing people to embrace the concept of eco-efficiency.

Drivers

With the rapid increase in population and economic growth, as well as a shift in focus from pollution prevention strategies to higher efficiency in products and services, companies have been driven by market forces to take environmental considerations into account, in the design, manufacture and use of products. Customers are becoming more environmentally aware and are demanding that products meet certain expectations. In order for products to be successful on the market today and in the future, they need to be sustainable. While these drivers influence the company's business strategy, maintaining a competitive advantage in the market for its products is probably the biggest driver behind eco-efficiency at BASF.

The main drivers in the development of the analysis tools were:

- **Strategic decision-making:** since it was necessary to have a tool that could easily encompass the different aspects of a project and summarize the results so that the decision-making process could be more effective, in spite of the time limitations required by the decision-makers.
- **Competitive advantage:** with customers could be achieved if the results of eco-efficiency projects as well as new initiatives are summarized in a manner that is comprehensible among this target group.

Tools

Eco-efficiency analysis is used to compare both economic and ecological considerations of several products or processes that serve the same purpose. It produces a condensed presentation of the facts of the case, which can be represented in visual terms and used in discussions with decision-makers. It is used to consider the entire life cycle of the product, from "cradle to grave" from the view of the end-users. In this way BASF considers all impacts of the product, even those outside its own operations, such as raw material extraction and end-of-life disposal.

In 1996 BASF began using eco-efficiency analysis to examine products and processes. This tool allows the company to seek out products with the best environmental performance at the lowest cost. It can be used to identify product improvements, to compare products to each other or to assess new product designs. The eco-efficiency tool employs the use of algorithms and calculations to compare products and/or their use, to position products and set product strategy. The tool utilizes information on risk, energy, materials, emissions and toxicity. These are used to derive an 'ecological fingerprint' (See Figure 1). This ecological data is then combined with economic data to indicate the level of eco-efficiency.

The 'fingerprint' is a compass that is used to compare alternatives. The environmental impacts are totaled in five weighted categories: materials consumption (25%), energy consumption (25%), emissions (20%), toxicity (20%), and hazard potential (10%). Beyond the subjective cultural factors, weighting is also based on objective factors such as relative importance, public opinion and regional considerations. Each of the categories is further broken down to cover a wide range of aspects. For example, emissions is categorized into air emissions, water emissions and wastes, and air emissions is further defined as greenhouse gas potential, ozone depletion potential,

photochemical ozone creation potential and acidification potential.¹ At the same time the economic data are tabulated, including all material, energy and incidental flows. The results of the analysis are plotted on a two dimensional graph called an eco-efficiency portfolio, with costs on the x-axis and environmental pollution on the y-axis.

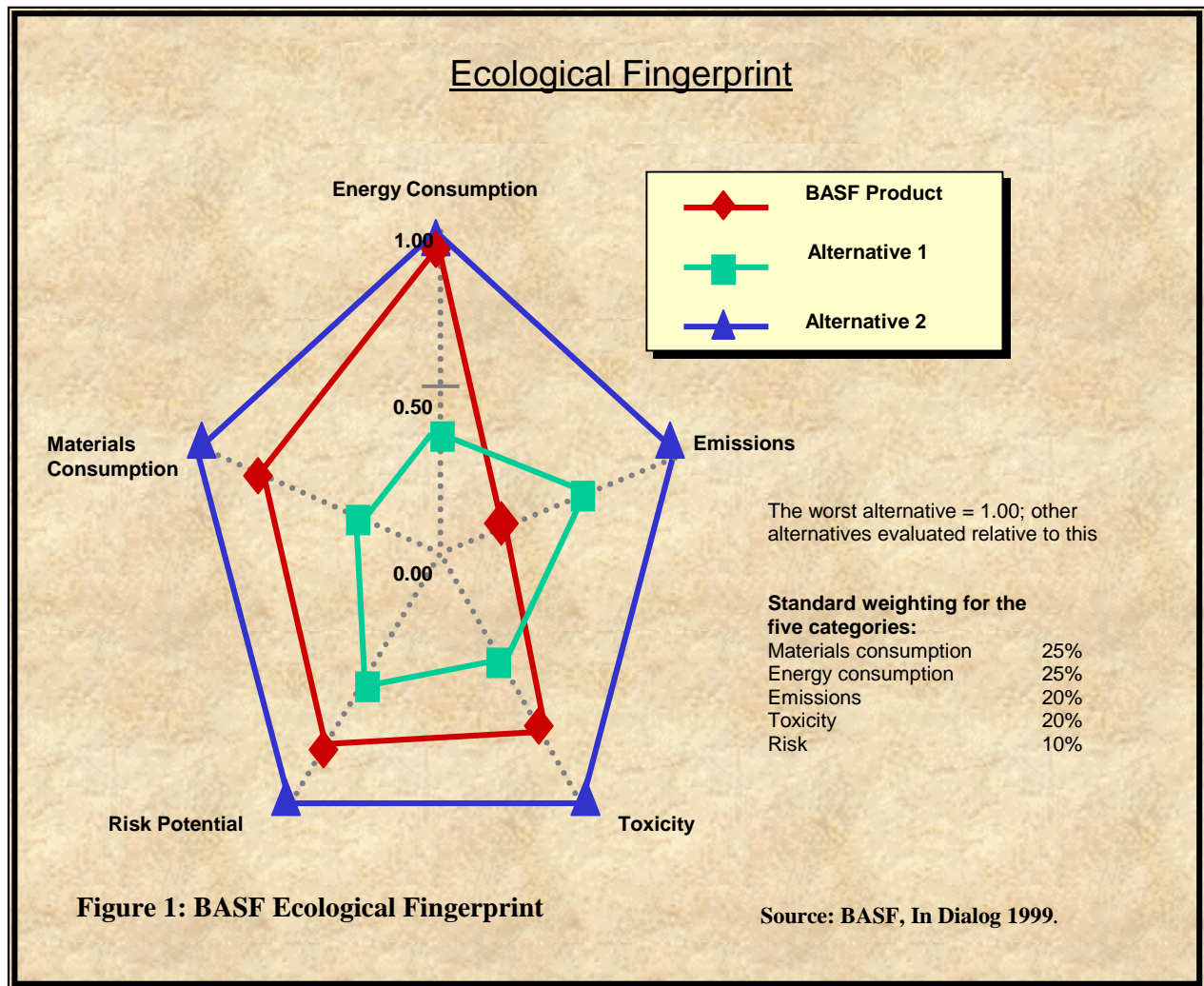
Generally an eco-efficiency analysis has four possible outcomes:

- (1) confirmation that the product/process has a high degree of eco-efficiency;
- (2) the product/process has low eco-efficiency, the economic or ecological component which must be improved is identified and optimized;
- (3) the product/process has low eco-efficiency but cannot be optimized--an alternative product may be substituted;
- (4) alternative options for a product in development may be analyzed and the best course chosen.²

The eco-efficiency tool was originally used as a strategy tool for design, but now it is also used for product improvement, but is now also used for product differentiation.

¹ BASF, In Dialog. November 1999

² BASF, In Dialog. November 1999



Benefits of Eco-efficiency

There are both internal and external benefits to the incorporation of eco-efficiency at BASF. Some of the benefits include the following:

- At BASF Corporation eco-efficiency is the primary tool to help position the company and implement its environmental vision. It also helps to develop a culture within the company that is necessary to lead the company in the direction of sustainable development.
- The market is a primary driver for the company, and the eco-efficiency strategy facilitates closer ties with the customer through a greater involvement at all stages of product development. This leads to improved customer relationships.
- Increased sales of company's sustainable products (especially visible in the short-term) and the ability to meet future market needs and drivers.

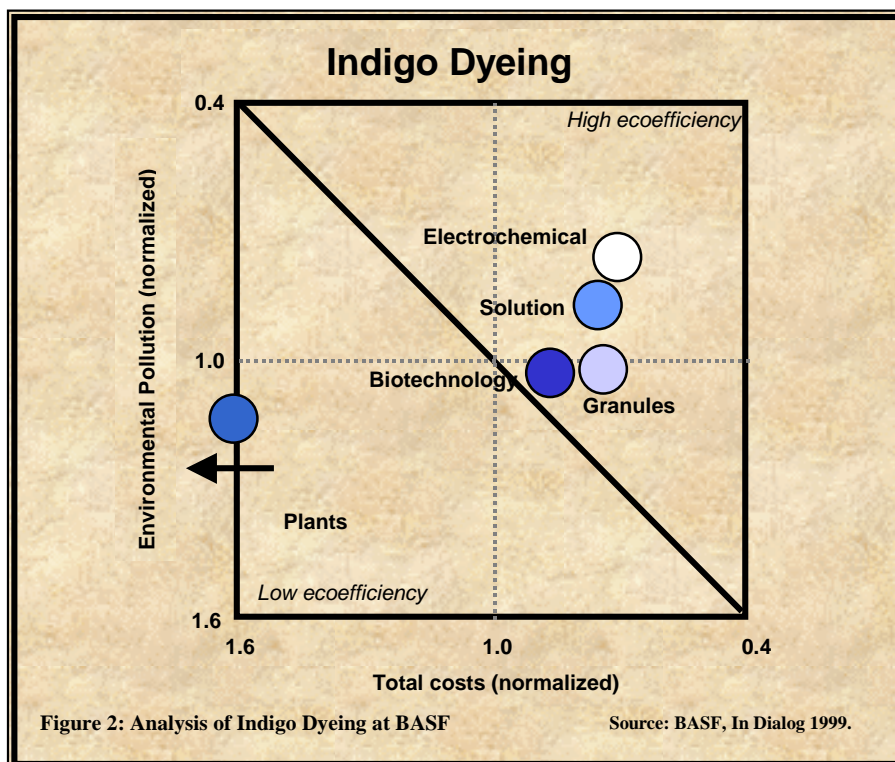
- Eco-efficiency aids in the evaluation of different material types at the research and development (R&D) stage to determine which material or combination of materials would provide the best environmental and economic benefits when used in a specific product.
- Eco-efficiency is a core issue analysis tool across the product's life cycle - it identifies the key cost drivers. BASF probably has the most tested tool given the large number of studies undertaken throughout the Group.
- Customers experience benefits as end-users, where they may save energy and money over a period of time by using a more efficient product.

Results

Indigo Dyeing Process

BASF has been a market and technology leader in indigo for the last century. In order to maintain its leadership, the company continuously looks for opportunities to optimize indigo production and application. As part of this process, an eco-efficiency study was undertaken on the manufacture of blue jeans. The study was limited to the critical parts of the blue jean production process: indigo production and blue jean dyeing.

Several alternative methods for dyeing jeans were investigated. They included the use of indigo from various sources, including plant, biotechnology and chemical synthesis, as well as a pre-reduced 40% solution, in the hydrosulfite process. A developmental electrochemical process, in which an electric current assumes the role of the hydrosulfite, was also included in the analysis.



As indicated on the eco-efficiency portfolio (See Figure 2), the use of the 40% indigo solution in the electrochemical process was the most eco-efficient of the alternatives studied. These results were valuable in developing BASF's business strategy for indigo. Following this analysis, the company decided to launch the 40% solution as a new product and made the necessary investment to produce the product in its Ludwigshafen production facility. In addition, BASF plans to further develop the electrochemical dyeing process in concert with two other partners.

Preservation of Cereal Crops

In a very similar manner, the eco-efficiency analysis tool was used to evaluate the preservation of cereal crops using propionic acid (present in two of BASF products) and compare this method with alternate methods, such as the use of silos, salt and continuous drying. It was found that these alternatives were more cost-intensive and led to greater environmental pollution.

This information was valuable since it facilitates more objective discussions of the subject of "chemistry in animal feeds".

Furniture

BASF also used its eco-efficiency analysis tool to evaluate the efficiency of a new process used in the manufacture of furniture boards and the efficiency of the conventional chipboard. The new process was offered to BASF as an investment project. With the help of this tool BASF was able to make a decision with respect to whether or not it should invest capital into this project. There was no significant advantage found by use of the new process, so BASF refrained from investing in this new process.

Asphalt Micro-Resurfacing Project

BASF Corporation worked jointly on a project that assessed a microsurfacing technology with a partner who is both a supplier and a customer. The technology makes use of a cold surface application of asphalt in wet slurry, as opposed to the traditional hot application. A number of environmental and economic benefits were attributed to this technology. These included: a reduction in energy used, a reduction in emissions, reduced labour requirements which translates into lower costs and a lower cost per mile of asphalt applied using the new technology as compared with the traditional method. The results of this project and sharing of information demonstrate the value and critical nature of the cooperation between suppliers and end-users necessary to develop eco-efficient products and processes.

Summary

In its relationship with the German and European governments, BASF has found that eco-efficiency is generally favored as a good tool, and has led to positive interactions with, and encouragement from, the government.

In the NAFTA region, there is a need for a more open approach displayed by the government with respect to eco-efficiency. BASF Corporation wants to be more visible in terms of the use of its eco-efficiency tool, and highlights this as being very important for stakeholder relationships.

The commitment of BASF to achieving sustainable development is born out by the fact that environmental and economic factors are considered equally throughout its incorporation of eco-efficiency into its products and services, and by the investment they have made in developing this method. BASF recognizes that in the future it will be unacceptable to ignore the environmental consequences of operating in the market, and that by taking early action the company will gain a competitive advantage.

2.2 Compaq Computer Corporation

“We will continue to help customers and suppliers identify innovative ways to use our products to improve their environmental performance as well as their businesses.”

- Michael Capellas, President & CEO, Compaq Computer Corporation

Corporate Overview

Compaq Computer Corporation is the second largest computer company in the world and the largest global supplier of computer systems. It currently ranks in position 29 of the 500 Fortune Global companies. Compaq develops and markets hardware, software, solutions, and services, including commercial desktop, portable products and consumer PCs.

In 1999, the company reported total revenue of \$38.5 billion. Compaq employs approximately 65,000 employees worldwide, and is organized into product groups serving markets in North America, Latin America, Japan, Asia-Pacific Rim, Europe, the Middle East and Africa. Its products are sold and supported in more than 100 countries through a network of authorized Compaq marketing partners.

The company is considered an industry leader in environmentally friendly programs and business practices as evident from its awards. In October 1998, Compaq was one of 19 organizations from eight countries to receive the Climate Protection Award for Corporate Leadership in Energy-Efficient Electronic Products, in recognition of its effort and achievements in protecting the global climate. The company was presented with the Stratospheric Ozone Protection Award in 1993, by the EPA, and in 1997, Compaq received the World Environment Center (WEC) Gold Medal for International Corporate Environmental Achievement– the world's highest recognition of global environmental, health and safety excellence.

Box 1: The Green Lights Program

The Green Lights program is voluntary program of the United States' Environmental Protection Agency (EPA). Participants of the program first sign a Memorandum of Understanding with the EPA and then conduct a survey of the lighting in all of their U.S. facilities. The next step is the installation of energy-efficient lighting systems in 90% of their facilities nationwide over a five-year period, where it is profitable and lighting quality is maintained or improved. The EPA, in turn, assists the participating organization throughout the retrofit process, providing lists of manufacturers, lighting management companies, and utilities, (all considered "Allies") who produce lighting products and provide efficient lighting services. The EPA also provides participants with a computer software program called the *Decision Support System* that allows corporations to survey lighting systems in their facilities, assess their options, and select the best energy-efficient lighting upgrades which maximize energy savings and are profitable.

Source: <http://es.epa.gov/partners/green/green.html>

Compaq has participated in the EPA's voluntary programs, and became a charter member of the Green Lights program (See Box 1) in 1991 and the ENERGY STAR program in 1992 (See Box 2). Compaq is the only company to be selected by the EPA to receive a major award in both the Green Lights and the ENERGY STAR programs. Last year, Compaq was chosen as the Green Lights 1998 Corporate Partner of the Year. In 1996 and again in 1997, Compaq was recognized by the EPA as the ENERGY STAR PC Partner of the Year.

Compaq is strategically organized to meet the current and future needs of its customers. Its corporate strategy is based upon its three core strengths: 1) global leadership, 2) brand strength based on quality and innovation, and 3) a partnership-based business model, providing customer-focused enterprise computing solutions at the lowest total cost of ownership.

The company eliminated the use of chlorofluorocarbons (CFCs) in worldwide packaging and manufacturing in 1992 and 1993.

Compaq made two acquisitions in the last three years, Tandem Computers Incorporated in 1997 and the Digital Equipment Corporation in 1998.

In February 2000, Compaq released its 1999 Leadership (Corporate Environmental) Report on CD-ROM. The company intends to produce future reports in a paperless format.

Business Context

The Compaq Computer Corporation is a major player in the computer and electronics sector. The sector is complex with many companies simultaneously acting as competitors and suppliers to each other. This situation forces some level of co-operation among the competitors.

Within the global market Compaq's operations and product sales are regulated and guided by a number of policies focused on the environmental aspects of product manufacturing, materials, and ease of disposal. Some of these policies include:

- *Waste from Electrical and Electronic Equipment* - this proposed directive from the European Union sets out measures that aim to: prevent waste from electrical and electronic equipment, increase re-use, increase recovery and recycling of such waste and minimize the risks and impacts to the environment associated with the treatment and disposal of end-of-life electrical and electronic equipment.
- *Take-back policies* – there are product, battery and packaging take-back policies in place around the world. Taiwan has implemented a product-labeling program where manufacturers purchase Taiwan EPA product labels that are placed on the IT equipment prior to sales to customers. The price of the label is based on the cost to dispose of the IT equipment in Taiwan. Customers can take properly labeled products to disposal sites for no additional charge at the end of the product's use phase. In Europe, there are several EU directives that target product, product packaging and battery disposal to minimize the environmental effects they have on Europe. Member countries of the EU must create local legislation that meets the objective of the directive. The "Green Dot" program in Germany, known as "Grüner Punkt", requires product packaging to be labeled with the "Green Dot" label. For this program, manufacturers pay a fee

Box 2: ENERGY STAR® Program

ENERGY STAR® is a voluntary partnership among the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers. Partners help promote efficient products by labeling with the ENERGY STAR® logo and educating consumers about the benefits of energy efficiency. Some of the products that are labeled in this program include: windows, office equipment, home electronics and electrical appliances, heating and cooling equipment and residential light fixtures.

In addition to labeled products, ENERGY STAR® offers voluntary partnerships which promote energy efficiency, reduce air pollution and saves money in both large and small businesses.

Source: <http://www.epa.gov/energystar.html>

based on amount of product packaging sold in the country to cover cost of recycling or disposing of the materials. There are many similar battery labeling and take back regulations in Europe and the US.

- *Material Bans* – A large number of private and public sector organizations are instituting bans and phase-outs of toxic substances. This is being done to reduce costs, risks and potential financial liability for environmental damage caused when these substances are released to the environment. An example is the restrictions on *Brominated Flame Retardants* (BFRs) in Sweden. BFRs have been the focus of national attention in Sweden with much negative publicity on television and in newspapers. The effects of BFRs on people and the environment have been well documented there. The Swedish government now includes an environmental declaration requirement in the procurement bid requests for IT equipment. In the declaration, manufacturers must state whether the product being considered contains BFRs in the plastics. Claiming to have BFRs in the plastics will likely disqualify the product from consideration in the bid. There is a proposed ban on BFRs entering Sweden, as part of a national phase out initiative. Compaq has phased-out the use of plastics that contain BFRs in its products. Compaq is in the business of supplying its products to a global market, and hence is more aware of policies and standards of other jurisdictions.
- *National eco-labeling initiatives* – Eco-labels are used to certify that a product is designed and manufactured to meet stringent environmental objectives. The criteria for achieving an eco-label can include many aspects of the product from a life cycle perspective. For example, eco-labels can require: minimum specified time for product warranties and spare parts availability; restrictions of hazardous materials in specific applications; energy consumption limits; product take-back; ease of upgradability, recyclability and disposal. There are several eco-label programs around the world that have regional importance to customers, therefore, it is important for manufacturers to understand market needs for specific eco-labels in the various regions and obtain certification as appropriate. There are also costs associated with implementation of eco-label criteria and the eco-label certification process that must be understood and weighed against the market upside for having the eco-label. At Compaq, the various product business units are responsible for determining the need for an eco-label to certify its products. Compaq's Commercial Desktop Division has certified its desktop PCs to Germany's Blue Angel eco-label criteria. Compaq's PC monitors are certified to Sweden's TCO eco-label criteria. Nearly all of Compaq's PC products are US EPA Energy Star eco-label compliant. Eco-label criteria changes periodically, with the bar being raised as environmental issues or practices become more important and manufacturers must be aware of how the changes may impact product design and customer acceptance. One such recent change occurred with the TCO-99 eco-label. From the previous level, TCO-95, the new requirements include verification of environmental criteria throughout the supply-chain. Declaration forms must be filled out and signed by companies that supply components of the product that is eco-labeled. This pushes environmental awareness and responsibility for products to deeper levels of the supply-chain, to suppliers that may know very little about worldwide environmental regulations. As a result, Compaq has to ensure that its suppliers meet the same standards, policies and regulations as would be expected of Compaq's internal operations and first tier suppliers. In an assessment of one of its products for an eco-label, Compaq discovered a restricted metal element present in some equipment from one of its suppliers. From this experience, Compaq has taken appropriate steps to educate its supply-chain on worldwide hazardous material regulations.

The acquisition of Tandem Computers Incorporated and Digital Equipment Corporation occurred in a short period of time and Compaq had to have some level of confidence that the environmental and economic liabilities were reasonable enough to make the worthy purchase of these corporations. Compaq proactively assesses all prospective property acquisitions to assure that Compaq is not exposed to unnecessary environmental liability. Compaq is proud of its environmental performance of its own operations and does not wish to acquire property that was not handled in an environmentally unsafe manner.

Environmental Strategy

Key Drivers

Compaq's key business, regulatory and environmental drivers are both internal and external. The main internal drivers include:

- reducing non value-added costs from inefficiencies in products and services and shifting those that do add value;
- potential differentiation of products or services, such as a change in design or improved efficiency which leads to a competitive advantage in the market;
- minimizing exposure to risks and liability directly leads to cost-savings and improved efficiency in operations;
- marketing of environmental performance - this leads to a competitive advantage for the company, its products and services as evident in bid requests.

The company's main external drivers include:

- responsibility to customers, community and shareholders;
- market forces, such as customer demands, change in regulatory requirements, programs and policies (e.g., ISO 14000 and eco-labels);
- enhanced brand image of company and products in the market – better brand image fosters confidence in clients and other stakeholders, improves relations with them and secures business for the company;
- being a good corporate citizen also adds value to the company's image and external relations.

In terms of product strategy Compaq usually has a baseline requirement of not getting disqualified in its bids. In general product strategy varies by business unit.

Environmental Leadership

In 1993, Compaq set forth to become a leader in environmental, health and safety (EHS) performance. However, defining and measuring "leadership" proved to be especially challenging. Therefore, Compaq enlisted the aid of various companies, consultants, industry associations, customers, shareholders and regulatory agencies. The result was not a single measure or performance indicator, but a list of six attributes that characterize the environmental leaders of today and tomorrow. The six attributes of EHS leadership are:

- *Management Commitment:* It starts at the top and is shared across the company and all employees are engaged in a role in EHS leadership.
- *Regulatory Compliance:* Compaq's compliance history reflects performance far greater than standard compliance criteria.
- *Products and Processes:* Many Compaq products meet environmental criteria such as the EPA Energy Star, the German Blue Angel or the Swedish TCO '95.
- *Communications:* Continuous communication keeps Compaq's customers, employees, suppliers and the community apprised of the company's leadership goals.
- *Assurance:* Compaq's global EHS audits ensure consistency, are the basis for continuous improvement and are recognized as among the most rigorous in industry.
- *Community Support:* Compaq supports numerous EHS organizations and projects in an effort to enhance environmental awareness and education worldwide.

Box 3: Compaq's Corporate Environmental Policy

Compaq is committed to conducting its business in a manner that delivers leading environmental, health and safety (EHS) performance and protects the quality of the communities where it operates. The company is committed to meet or exceed all applicable EHS regulatory requirements, as well as its own EHS management standards. Compaq will aggressively pursue pollution prevention and waste reduction; encourage reuse and recycling; conserve natural resources; proactively reduce injuries and illnesses; promote healthy lifestyles; and incorporate state-of-the-art EHS practices into its operations and throughout the life cycle of its products and services.

Compaq will accomplish this high standard of performance through strong EHS management systems integrated within its business planning and decision-making processes and by setting and tracking measurable EHS goals and objectives. In addition, each employee has an individual responsibility to follow EHS procedures and participate proactively in its EHS programs and committees. Compaq will evaluate its own EHS performance as well as that of its suppliers and promote continuous improvement.

Compaq believes business must work in partnership with suppliers, customers, government agencies, and community organizations to help protect and improve the environment. Compaq will foster openness and communication with all its key stakeholders in order to anticipate important EHS concerns, share relevant information, contribute to development of sound solutions, and respond in a constructive and timely manner.

The company vision is to continue Compaq's tradition of EHS leadership and to practice sustainable development. By carefully blending ecological, social, and economic considerations into its business planning and decision-making processes, Compaq will balance the interests of the present with those of future generations.

Source: <http://www.compaq.com/corporate/ehss/policy.html>

Corporate Environmental Policy

The cornerstone of Compaq's environmental leadership is found in its current Environmental Policy (See Box 3). Formalized by the company's senior management team in 1989, the Policy solidifies the underlying philosophy that has been integrated into the company's business strategy and environmental, health and safety management systems. The Environmental Policy is dynamic and has recently been revised for the third time to reflect changing international environmental priorities and concerns.

Compaq's Environmental Policy prompts proactive behavior, which extends far beyond environmental regulatory compliance requirements. On a worldwide scale, it encourages Compaq

employees to be creative in identifying solutions that enhance the company's drive toward sustainable development.

Implementation

Compaq's Environment, Health, Safety and Security (EHS&S) strategy is to hold individual business units responsible for their own EHS&S liabilities and risks and to have a lean EHS&S technical staff in a centralized corporate organization that facilitates the actions of the business units. Compaq's corporate EHS&S organization consists of a group of highly skilled EHS&S professionals that track worldwide regulations and trends, creates programs and policies for the rest of the company to follow, and acts as internal consultants to the rest of the company. The EHS&S group is comprised of experts in mergers and acquisitions, products, audits and remediation. The experts are expected to act like business people, show leadership, add value, be focused, foster competitive advantage and prioritize. In addition, there are EHS&S "generalists" positioned within each of the business units, with the responsibility for implementing processes and training.

Compaq's EHS&S strategy includes a value-added approach. Business is the ultimate driver behind the positioning of Compaq in the market place, and it defines the way in which work is done by the company's marketing people. Similarly, business opportunities are sought after in the EHS&S area. The EHS&S group is therefore positioned as a business partner for the company, and members often assist marketing personnel by gathering product environmental information and answering specific environmental questions required for the sale. Many of the programs run by the EHS&S organization have the ultimate goal of either reducing risks, saving money, enabling sales or improving image, with an eye to make Compaq more profitable.

EHS&S operates with a relatively lean corporate staff. Prior to the acquisition of Digital there were 14 EHS&S staff at the corporate level, but there are 26 members at present - five are environmental people, four handle safety issues, fourteen are involved with security matters and two are auditors. To show leadership commitment to EHS&S issues at Compaq the company found that it was necessary to delegate responsibility directly at the upper management level, hence a Vice-President is also included as an integral part of the EHS&S staff.

Corporate EHS&S sets performance standards, provides guidance and performs internal audits to verify that the standards are followed. Audits are required for all business units and the business units are audited on performance standards that are relevant to the type of operations performed by the business unit. During an audit, the manager of the business unit is individually responsible for EHS&S issues found in the audit. Audits are integrated into the business plans of Compaq's various business units.

Compaq's operations did not include many high-risk environmental issues, so there was a need to market the EHS&S value-added approach to the business units. These operations are only really successful if the management team has buy-in and ownership. This is often a challenge for many large corporations that try to effect a change in management procedures in response to business and environmental drivers. Compaq is "still young enough, not to get set in its ways" according to Environmental Program Manager, John Burkitt. This makes it easier for Compaq to maintain a competitive edge in a market where there is a rapid product turnover and changes in strategic management.

Environmental Management Systems

The Compaq management system is the key to sustainable environmental, health and safety performance, and serves as the framework for its environmental management system (EMS) program. This management system defines the roles, responsibilities and actions required by its management team, employees and EHS&S professionals. An objective of Compaq's EMS is to integrate environmental efforts into the business management processes and systems.

Compaq has a stringent global EMS and chose to evaluate ISO 14001 based on customer needs and business value. Rather than dictate certification as an overall corporate mandate, each site evaluates the decision to pursue certification to ISO 14001 or any other environmental standard. This strategy has resulted in increased ownership, accountability and knowledge of ISO 14001 requirements throughout the corporation. Approximately nine Compaq sites have achieved ISO 14001 certification and there are two sites that are planning to undergo certification. There are a number of sites in Europe that will be ISO 14001 certified in the near future.

Accountability is ultimately the responsibility of the EMS Management Team. Tools, processes, infrastructure, standards and audits are the responsibility of the Corporate Group. The Line Group implements the process.

Box 4: A comparison between Compaq's Management System and a Compliance Based system

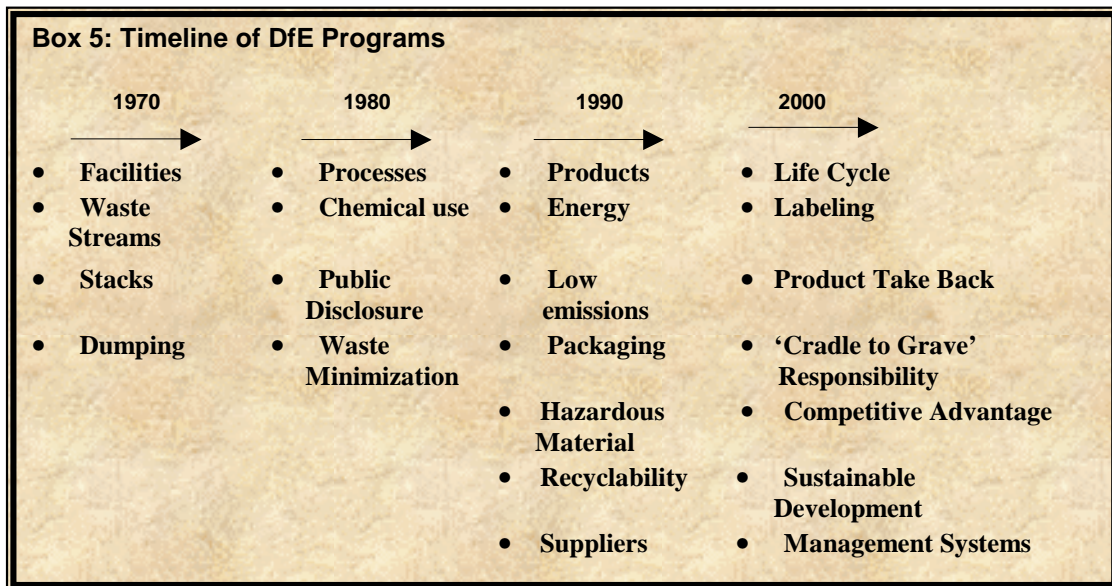
Management System	Compliance
Internally Driven	Externally Driven
Business value added (e.g., cost savings, reduced liabilities, etc.)	Required (e.g., competitive advantage, relationship with customers, community, and shareholders)
Continuous Improvement of products and services over a period of time	Point in time measure
Non-prescriptive	Prescriptive approach

Design for Environment

Compaq integrates sound environmental considerations into all of its processes, including the design and manufacture, use and ultimate recycling of Compaq products.

Compaq's "Design for Environment" (DfE) approach focuses on environmental stewardship during every phase of the product life cycle. For example, when Compaq engineers begin the design of a computer, they consider the environmental impact of its component parts and their readiness to be recycled when the computer is no longer useful. DfE Guidelines have been developed for use across Compaq product lines on a worldwide scale. Formalized in 1994, DfE Guidelines emphasize several key principles:

- *Energy Conservation:* Products that minimize energy consumption during both active and inactive periods facilitate preservation of worldwide energy resources, reduces associated pollution and greenhouse gas emissions. A focus on energy conservation reduces operating costs that lead to savings for the customer.
- *Disassembly:* Concepts learned from the company’s global network of recycling partners have been integrated into mechanical design practices. Compaq’s product designers plan for the end of a product's life, when computer components can be recycled.
- *Reuse and Recyclability:* Compaq products use materials that can be easily identified and recycled, employing available recycling infrastructures. Ease of recyclability will help its customers reuse or recycle products at the end of their useful life.
- *Packaging:* Packaging materials are the first product aspect a customer sees and handles. Additionally, packaging is the initial source of waste generated by a product once it enters the market. Kept to a minimum under DfE Guidelines, the company’s packaging is composed of recycled materials and uses no heavy metal inks. The company requires at least 35% recycled materials in all corrugated papers for packaging. Compaq’s packaging is made of materials that can be easily identified and recycled.
- *Upgradability:* Compaq incorporates design features that will aid in extending the life of a computer. Features such as microprocessors, memory, internal storage and other subsystems that can be upgraded will aid in the prevention of early product obsolescence.



During the 1970s, the environmental programs of the electronics industry were site focused and operations oriented, but within a decade the program's focus shifted to pollution prevention. In the 1990s environmental product design became important. Extended producer responsibility, where products are managed throughout their entire life cycle will be the focus for 2000 and beyond (See Box 5).

Drivers

Some of the drivers behind Compaq's Design for Environment (DfE) program include:

- Internal expectations - Consideration and implementation of appropriate DfE practices is expected of our product development organizations. Business units can choose to go beyond standard DfE practices as dictated by other drivers.
- Market driven – Business units must track customer expectations to understand the need to implement various DfE practices. This driver varies significantly by geographic region and product type. Therefore, DfE practices used in some product lines may not be used by other product lines.
- Environmental leadership – Compaq's image as an environmental leader in the computer industry has opened many doors to customers. Compaq positions DfE practices used in products as a value to the company's customers and leads to a competitive advantage. Advantage has been gained through Compaq's involvement with other programs such as the Swedish TCO'95 for monitors, the Energy Star rating for personal computers, product take-back initiatives, elimination of CFCs in products and reductions in VOCs.
- Competitive pressure – being aware of what Compaq's competition is doing from a DfE standpoint is vital to staying competitive. New practices used by our competition can become a standard requirement by customers. Our competition has implemented practices that include all aspects of the product life cycle.
- Total cost of ownership for customers – Compaq's marketing teams are able to communicate total cost of ownership considerations, such as energy costs and disposal options, to customers to see how Compaq's DfE efforts impact more than just the purchase price.
- Value-add to Compaq – Implementation of DfE practices can lead to: lower cost products; higher customer acceptance; lower service and upgradability costs; lower recycling/disposal costs. It is cost effective to have DfE guidelines for business.

Environmental Eco-labels

Compaq integrates numerous features into the design and manufacture of its products in an effort to reduce environmental impact over their life cycle. In Europe, two recognized and respected eco-labels signify the company's dedication to manufacturing environmentally sound products.

Many Compaq products in Europe carry Germany's Blue Angel eco-label and Sweden's TCO '95/'99 designation. The Blue Angel and TCO '95/'99 programs identify products that are environmentally-friendly, recyclable and easily serviced. Compaq's commercial desktop product families are certified with the German Blue Angel eco-label. The Blue Angel indicates these Compaq desktop computers minimize negative impact on the environment in their design, ergonomic properties, safety, power consumption and documentation. The complete range of Compaq commercial monitors are certified

to wear the TCO '95/'99 emblem, an indicator of monitors that are energy-efficient, emit minimal electric and magnetic fields, and are produced in an environmentally sound manner.

Supply-Chain Management

Compaq has implemented a supplier development process to regulate their supply-chain. The suppliers are given a questionnaire to fill in information about their policy and commitment, compliance history, processes and assessment, their suppliers, CFCs and other hazardous materials, and their waste minimization initiatives. A scoring system is used to evaluate the supplier's performance. Suppliers that score poorly on important environmental criteria may be ruled out as a supplier.

In terms of material specification, the suppliers' policies must meet or exceed regulations. Compaq includes a "Regulated Material Specification" on part drawings and engineering specifications to help suppliers understand the worldwide requirements.

Compaq's EHS&S criteria included on part drawings and purchasing contracts is tracked to assure compliance with the requirements. During supplier visits, procurement personnel will audit supplier data to assure compliance of EHS&S criteria.

Results

Compaq has become very proactive with regard to environmental initiatives, and in turn has realized many business benefits. The company has the lowest accident/injury rate in the industry. Its insurance modification rate is 0.3 (1.0 average).

Compaq's Houston operation has undertaken a number of initiatives in an attempt to reduce overall energy consumption. Compaq is involved with the U.S. Green Lights program and through that program it has retrofitted lights on the Houston campus with ones that are more energy efficient. The windows on the buildings were covered with plastic to help improve the efficiency of the air-conditioning systems by reducing air leaks. Compaq saves approximately \$975,000 annually as a result of this initiative.

Compaq's use of eco-labels has enabled Compaq to meet most customer environmental requirements around the world. TCO has become a recognized standard for computer monitors largely because of Compaq's widespread use of the eco-label. The Compaq's eco-labeled products are capable of meeting the more stringent environmental requirements of our customers and therefore, enable many sales.

Compaq's waste minimization efforts include the use of reusable packaging in manufacturing. This process has saved Compaq hundreds of thousands of dollars and has made a significant reduction in packaging for the products that were shipped via removable packaging. It is a good example of how Compaq can pursue environmentally friendly processes while showing significant savings to the business.

Compaq's ability to answer customer bid required environmental questions favorably has enabled Compaq to continue to sell IT equipment to the ever increasing environmentally conscious

customers. Compaq recently won a \$750M bid with a large European customer who required significant environmental data as part of the bid process. Compaq responded to the bid request and satisfied all the environmental requirements. Answering some of the critical requirements negatively would have disqualified Compaq from the business.

Summary

The computer and electronics sector has been shaped by regulation and policies in a number of different jurisdictions that have driven manufacturers to look at energy efficiency, environmental performance and product take-back. These demands have driven Compaq to look more closely at its product strategy, and modify it in order to be consistent with customers' expectations and regulatory demands. Compaq has decided to take a leadership position and has employed the use of tools such as design for environment (DfE) and environmental management systems (EMS) to address these requirements. The company has also recognized the value in rigorously managing its supply-chain in order to stay competitive. These initiatives coupled with design innovations have helped in positioning Compaq as a leader in the computer manufacturing market.

2.3 DaimlerChrysler Group

“We strive to develop products which in their respective market segments are highly environmentally responsible.”

- Environmental Protection Guideline No. 2 of the DaimlerChrysler Group

Corporate Overview

DaimlerChrysler, a global manufacturer of automotive and transportation products, was formed by the 1998 merger of two previously well-established enterprises – Germany’s Daimler-Benz and the American-based Chrysler Corporation. DaimlerChrysler manufactures passenger cars, mini vans, small cars, light trucks and commercial vehicles as well as civil helicopters, satellites, commercial aircraft and rail systems. Vehicle manufacturing accounts for 85% of consolidated sales, contributing over EURO 112 billion. DaimlerChrysler also produces electronics and diesel engines, manages telecommunications, and offers financial services for its customers and dealers.

European, U.S. and other international investors own this EUR 131.8 billion company, which has a net income of EURO 6 billion. DaimlerChrysler employs approximately 442,000 people, manufactures in 34 countries and sells its products in more than 200 countries. Some of the company’s products and services are marketed under the following names: Mercedes-Benz, Chrysler, Plymouth, Jeep®, Dodge, smart, Freightliner, Sterling, Setra, Airbus, Eurocopter, Ariane, debis, Adtranz, MTU, TEMIC and others

The company’s group headquarters are located in Stuttgart, Germany, and Auburn Hills, Michigan, USA.

Recently DaimlerChrysler has spent approximately EURO 770 million for environmental research and development for Mercedes Benz, and US\$ 770 million for similar work for Chrysler. The company also bought Ballard shares, a major investment into renewable energy sources (zero emission cars and buses).

Together with Shell and Norsk Hydro, DaimlerChrysler embarked upon a project, in Iceland, which investigated sustainable energy production for the whole island, solely based on renewable energy sources.

DaimlerChrysler’s strategic goal is to be a global provider of automotive and transportation products and services, generating superior value for its customers, its employees and its shareholders.

The company’s goals include:

- Anticipating and exceeding the expectations of its customers
- Having a unique portfolio of strong brands, products and services
- An integrated enterprise that will achieve maximum value from shared resources and expertise

- Profitability superior to all other automotive and transportation products and services companies
- Sustained profitable growth that will outpace the best of the company's competitors
- A truly global company building on its strong presence in North America and Europe while expanding into growth markets.

The company is more than just a vehicle manufacturer - DaimlerChrysler Services (debis) AG offers an extensive portfolio of services in the financial, IT and telecommunications sectors, including environmental services such as the consulting activities of Debis Risk Consult. The merger of the activities of Chrysler Financial Company L.L.C. and the financial services offered by debis has made DaimlerChrysler Services the world's fourth largest financial services provider outside the banking and insurance sector.

DaimlerChrysler Aerospace (*Dasa*) is Germany's largest aerospace company and a global player in civil and military aviation, as well as space travel. The Civil Aviation Division responsible for the company's Airbus activities – DaimlerChrysler Aerospace Airbus GmbH (DA) – is the largest at *Dasa*.

Adtranz is one of the world's leading suppliers of railway systems. The group's product range extends from electric and diesel locomotives for high-speed trains and streetcar units to traffic management systems.

TEMIC manufactures electronic components for the automotive industry. In 1998, for example, the company developed a crash sensor and an intelligent distance control system based on radar and infrared technologies. Huntsville Electronics also produces electronic components for automobiles. The company grew out of Chrysler Corporation's involvement in the U.S. government's space program.

MTU *Friedrichshafen* (Germany) is a leading manufacturer of large diesel engines and complete drive systems. More than one half of its sales are accounted for by marine propulsion systems, but the company also supplies engines for railroad applications and heavy vehicles, as well as serving the decentralized power generation segment.

With this palette of activities, DaimlerChrysler is active in all modes of transportation: road, rail, air and sea.

Business Context

DaimlerChrysler is a major player in the automotive market. It is a world market leader with respect to the manufacture of trucks, buses, trains, helicopters and rockets. It is second globally to Boeing in the manufacture of airplanes. DaimlerChrysler holds third position with respect to quality and image. Its automotive competitors include BMW, Ford, General Motors, VW, Honda, Toyota and Volvo.

As part of the auto-manufacturing market DaimlerChrysler has to be aware of international and national policies regarding their responsibilities for their products. One such regulation is the European Union's End-of-Life Directive for vehicles. This piece of legislation is designed to make

vehicle dismantling and recycling more environmentally sustainable by establishing quantified targets for reuse, recycling and recovery of vehicles and their components. The objective is to encourage producers to consider recyclability of materials used in the manufacture of new vehicles. The Directive requires last owners to have a certificate of destruction, which proves that the end-of-life vehicle has been handed over to an authorized facility for dismantling and treatment. Original Equipment Manufacturers (OEMs) have the responsibility of taking back cars at their end-of-life without any cost to the user, and ensuring that 90% of the vehicle weight, for each vehicle, is recycled. Heavy metals such as lead, mercury, cadmium and hexavalent chromium contained in vehicles will no longer be shredded, land filled or incinerated, and will either be recycled or phased-out. Lightweight materials such as magnesium plastics, reinforced plastics, will probably be banned in the future due to the difficulty in recycling these materials. This poses major problems for auto-manufacturers.

As a manufacturer of vehicles, the company also has to be aware of the fact that their manufacturing processes and products produce greenhouse gas (GHG) emissions, which in turn contributes to climate change, a major global environmental issue. Some 18% of CO₂ emissions in Germany today are attributable to road transport, while in the USA the figure is around 30%. Reduced fuel consumption is a key to reducing emissions of this greenhouse gas. DaimlerChrysler has to ensure that its vehicles consume less fuel and produce very low emissions of these gases in order to have and maintain a competitive advantage in terms of the business aspect of environmental issues. To this end, product innovation is important to the company's success. DaimlerChrysler is committed to reducing the GHG emissions of its fleet by 25% by 2008, with the aim of exceeding this set goal.

In addressing similar environmental concerns, manufacturers in other sectors are now concentrating on the service that they could provide as opposed to spending a lot of time and resources into the development of their products. Some companies are investigating the option of providing the service of a vehicle for short-term use as required by the customer. Daimler-Benz operated an internal car-sharing system, known as the "Personal Works Transport". The system was operated as a company pilot-project where its employees were provided with a vehicle upon request and a coded chip card, which unlocked the car door and monitored the availability of the vehicle for the next user. The employee could then drive the car to his/her destination, park in a car pool lot, and return the chip card there.³ Later on the employee could obtain another vehicle and chip card from the same lot for a return trip or make alternate transportation plans. Some of these car-sharing initiatives are already available to the public in Europe and North America, and are being successfully operated.

In the future the energy sector will most probably face increasing pressure to provide less carbon intensive options, in response to global climate change policies and regulations. DaimlerChrysler has incorporated these concerns into its research and development and has already taken steps to address this issue. Some of these initiatives include work on diesel engines, electric propulsion systems and the development and use of hydrogen fuel cells in some of its vehicles.

DaimlerChrysler is the first automaker worldwide to offer fuel cells vehicles on the market. DaimlerChrysler, along with the California Air Resources Board (CARB), the California Energy Commission, Ballard Power Systems, Ford Motor Company, ARCO, Shell and Texaco have created the "California Fuel Cell Partnership" to advance automotive fuel cell technology. The company's NECAR 4 is a zero-emission vehicle, which uses fuel cell technology to generate electricity. Based on the Mercedes-Benz A-class compact car, NECAR 4 can go up to 130 km/h and travel nearly

³ Daimler-Benz Corporate Environmental Report, 1997.

450 km before refueling, an unprecedented driving range for a zero-emission vehicle. In addition, engineers have been able to mount the complete fuel cell system in the vehicle floor for the first time, allowing room for up to five passengers with plenty of cargo space.⁴

DaimlerChrysler just recently released to the market the Citaro, a new fuel cell-driven bus. The Citaro's fuel cell unit delivers more than 250 kilowatts of power. It was developed and manufactured by the DaimlerChrysler subsidiary Xcellsis. The gas pressure bottles containing compressed hydrogen are mounted on the roof of the bus. The Citaro can travel up to 300 km at a top speed of 80 km/h and carry around 70 passengers.⁵

While hydrogen fuel cell vehicles will probably be in wide use in the future, companies are seeking recourse in an intermediate hybrid technology. DaimlerChrysler's five-passenger ESX3 is one such hybrid that uses both gasoline and batteries. The ESX3 has a lightweight injection molded plastic body and a 1.5-litre direct injection diesel engine and battery-powered electric motor to drive the front wheels. The electric motor also captures energy used in braking, storing it in a battery pack in the trunk. It uses a small high-powered lithium-ion battery with the potential for lower cost and longer life than traditional nickel metal-hydride or lead-acid accumulators. This vehicle has a driving range of 640 kilometers (240 kilometers above the average range of a traditional gasoline run vehicle), in part because it recaptures and reuses energy generated by the braking system.

There are other approaches that are being developed by the automotive sector to reduce emissions and to increase energy efficiency in vehicles. One approach utilizes an emerging technology called "infotronics", (on-board computers linked to the Internet) that manages the power systems for maximum efficiency. Another approach is the change in design of the vehicles by using lighter weight materials, such as the use of aluminum and fibre-reinforced plastic, which will reduce the amount of energy required to operate the vehicles.

But conventional cars and commercial vehicles emit pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbons (HC) and diesel particulate matter (PM) can all be harmful to health. NO_x emissions lead to the formation of nitric acid and are thus partly responsible for acid rain. NO_x emissions and hydrocarbons also contribute to the formation of ground-level ozone, creating a further pollutant in the atmosphere.

Using state-of-the-art technologies, pollutant emissions have been drastically reduced right across the vehicle range. Excellent results have been achieved for the larger Mercedes models in particular. Their engines are now very low-pollutant and make use of highly sophisticated – and expensive – emission control systems. The pollutant emissions of the new S-Class, for example, comply with both the stringent German D4 emissions limits and the strict Californian standards for ultra-low emission vehicles (ULEV). The Mercedes-Benz S-Class is in the forefront of low emission vehicles.

Other key future trends that may influence the way that DaimlerChrysler does business includes the development of material and process technologies that leads to recycling, renewables and eco-efficient processes. There may also be a shift from the provision of transportation products to the

⁴ California Fuel Cell Partnership, April 1999. http://www.daimlerchrysler.ch/index_e.htm?/products/products_e.htm

⁵ First Fuel Cell for Customers, April 2000. http://www.daimlerchrysler.ch/index_e.htm?/products/products_e.htm

provision of mobility services as a method of utilizing less polluting and more efficient forms of transportation.

Environmental Strategy

Key Drivers

Shareholder value is the key business driver at DaimlerChrysler, with revenue and profit optimization, larger production numbers and cost-cutting programmes as other major internal drivers. Liability is mainly an issue from the US side of the company's operations, but is well managed through the implementation and use of environmental management systems such as ISO 14001.

Emissions control, recycling and energy policies are strong drivers at DaimlerChrysler, since the company's activities and products are contributors to major global environmental issues. The company aims to be beyond compliance by striving to be ahead of all standards, influencing policies and other regulatory drivers. It is hoping to shift the end-of-pipe legislation to a more innovative approach for dealing with compliance issues and regulations.

DaimlerChrysler recognizes mobility as an essential need, but is also aware of the negative impacts of a high volume of traffic - air and noise pollution and high-energy consumption. DaimlerChrysler is aiming to help make mobility as environmentally acceptable as possible. From the development and production stages, through the product's service life, all the way to its recycling and disposal, the Group applies stringent environmental standards.

One example of success with this approach for DaimlerChrysler was the improvement in corporate average fuel economy for all passenger cars sold in Germany between 1997 and 1998, from 9.2 to 8.7 liters per 100 kilometers (measured in line with the New European Driving Cycle); bringing the drop in average consumption between 1990 and 1998 to 15%.

DaimlerChrysler is aware that it must also make environmental requirements an integral part of its research and development activities. One example of this awareness is found in DaimlerChrysler's intensive efforts at being first to market with an economically viable production model with fuel cell propulsion. Through its partnership with Ballard of Canada, DaimlerChrysler is already the technology leader. By incorporating such advances in technology, there is an increase in the already premium prices that customers pay for vehicles manufactured by DaimlerChrysler. These market prices do hinder to the company's customers, because they pay more

Box 1: The Environmental Protection Guidelines of the DaimlerChrysler Group

1. We face the environmental challenges of the future by working continuously to improve the environmental performance of our products and our operations.
2. We strive to develop products, which in their respective market segments are highly environmentally responsible.
3. We plan all stages of manufacturing to provide optimal environmental protection.
4. We offer our customers ecologically oriented service and information.
5. We endeavor to achieve exemplary environmental performance worldwide.
6. We provide our employees and the public with comprehensive information on environmental protection.

for premium brands but expect more in return. For example, customers expect that environmental considerations are included in the market prices.

Main external environmental drivers include the relationship with community, other stakeholders and enhanced public image. The company gets involved with neighborhood communities and proactively works with them. In the past, lobby groups, such as Greenpeace, would pressure the company on a variety of environmental issues. These groups are now involved in company activities, for example, when the company opened a new engine plant with solar roof panels, the environmental minister of the Green Party visited the site, and this reinforced a good public image for the company.

Corporate Vision, Environmental Policy and Strategy

DaimlerChrysler envisions itself as an industry leader that proactively integrates environmental protection into its corporate policy and strategy. The company uses a life cycle approach to address compliance issues. The aim of this approach is to always be beyond compliance in the major areas of concern: energy efficiency for products and processes, emissions, noise and resources. DaimlerChrysler's goal of maximum product quality includes compliance with stringent environmental standards and careful treatment of the natural foundations of life. Accordingly, the company's approach to environmentally acceptable product design requires careful consideration of the entire product life cycle from design, production and use to disposal or recycling. Through these environmental initiatives DaimlerChrysler tries to add value for its stakeholders, employees and clients.

The Environmental Protection Guidelines (Box 1) approved by the Board of Management define the environmental policy of the DaimlerChrysler Group and describe their commitment to integrated environmental protection that addresses environmental impacts at their roots, assesses in advance the ecological implications of production processes and products, and takes these findings into account in corporate decision-making. Appropriate control and monitoring procedures and measures have been implemented. Responsibility for the implementation of and adherence to environmental protection measures has been assigned to specific employees in all functional areas, from development and production to sales and service, and at all corporate staffs.

The company's strategy is communicated through a variety of methods and media including: environmental reports, internal newspaper, training seminars, environmental days, environmental education programmes for all employees (as part of the ISO 14001 and EMAS) and through the inclusion of environmental departments in all decision-making processes.

Implementation

One particular strongpoint of DaimlerChrysler's European operations lies in the sophisticated Environmental Management System (EMS) already in place. All of the former Daimler-Benz AG production plants in the European Union are certified in line with the Environmental Management Audit Scheme (EMAS). The company also uses the ISO 14001 EMS, and aims at certifying all plants by 2001. The ISO 14001 EMS is facility based, and each facility has a self-responsible environmental officer. This represents a very high standard of site evaluation. At present, work is in progress on the development of a general system of parameters that will enable the key

environmental facts and figures for the various divisions to be represented in readily comparable form, and evaluated for use in corporate communications and decision-making.

DaimlerChrysler set the following targets and objectives to be achieved through the environmental management system:

- To achieve a 25% reduction in emissions and increased fuel economy by 2005;
- To reduce, by 40%, the variety of material types by 2015 – e.g. by manufacturing the parts of automobiles (dashboards and fenders) from a single piece of molded plastic;
- To achieve 95% recyclability rate with their recycling initiatives;
- To track legislation with regards to emissions and finding alternative engine concepts;
- To move towards providing mobility for customers with a zero emission target;
- To provide environmental training at all of the company's plants;
- To perform audits on suppliers and manage the supply chain. DaimlerChrysler requires its suppliers and contractual partners to comply with all applicable laws and regulations and encourages them to pursue proactive environmentally responsible practices. Contractors working on DaimlerChrysler properties also must comply with the location's own standards and requirements.

A Stationary Environmental and Energy Department was set up, by the company, with the following responsibilities:

- Defining environmental compatibility strategy and plan realization for all plants;
- Develop, assess and evaluate the company's strategic plans and align these with the legislative requirements for air quality, water, emissions, waste and remediation administration;
- Administrating and executing these strategic plans to minimize operational risks, minimize investment costs and maximize plant availability;
- Developing and administrating a 5-year capitalization plan that includes environmental budgeting;
- Executing environmental audits for sites and suppliers;
- Reporting internally and reporting to the government;
- Developing and executing environmental training and communication, including press releases, training workers and newspapers;
- Developing of a corporate energy efficiency manual.

A Pollution Prevention department was also created to develop strategies and organized global projects that are geared towards proactive environmental management. This department is responsible for reducing negative environmental impacts of products and sites through the use of Life Cycle Management (LCM) approaches, Design for Environment (DfE) and Environmental Management Systems.

Eco-Efficiency

Environment is looked upon as a cost driver since advanced technologies that consume less energy and resources, typically cost less in the long run. Following this perspective, DaimlerChrysler concentrates its efforts and investments on research and development activities that lead to the development of more resource and energy efficient forms of production. Some of these activities include: detailed assessments and benchmarking studies of processes between plants, benchmarking

studies on competitors that evaluate their products, and the integration of DfE into the company's product design strategy.

Some eco-efficiency initiatives at DaimlerChrysler include the following:

New painting process: With the new low-emission painting process introduced for the A-Class, DaimlerChrysler has set an environmental benchmark. An innovative aspect of the new integrated painting concept, which uses water-based paints, is the powder slurry clear coat that is applied in the form of a powder, finely dispersed in water. The new powder paints consume less energy and can be recycled much easier

Engine tests without fuel: At the *Untertürkheim* plant (Germany) cold engine tests are superseding conventional hot testing. From 1999 onward, 90 % of tests will be run to the new method in which air is injected into the combustion chambers in place of fuel. Cold tests save the plant 1.1 million liters of fuel annually – enough to heat 400 family homes.

Closed-loop cooling: At the *Wörth* truck plant (Germany) progressive conversion of the production equipment and building cooling systems to closed circuit cooling has brought a dramatic fall in water requirements. Since 1994, consumption has dropped from 1.5 million m³ to 123,500 m³ a year – a reduction of 92 %.

Fewer coolants: In the past, milling a crossbeam for an Airbus from an aluminum blank weighing several tons required 11,000 liters of cooling/lubricating emulsion. Now, at its *Augsburg* plant, Dasa is testing a new “low-volume lubrication” technology that needs the equivalent of just two eggcups of a special oil. The process offers many benefits for the environment: no more reconditioning of used emulsion or disposal of residues, and the aluminum swarf (several tons per cross-member) can be easily recycled.

Life Cycle Management (LCM)

DaimlerChrysler's product strategy on avoiding non value-added costs consists of compliance with legislation and the use of Life Cycle Management (LCM). In the North American operation, DaimlerChrysler uses LCM to identify ways to help shed the company's regulatory burden, by looking at all issues simultaneously. Life Cycle Costing (LCC) is one of the tools used by the company to detect hidden costs in the areas of EHS and in the recycling costs of substances. DaimlerChrysler estimates these hidden costs of restricted materials to be US \$2.5 billion, over a period of five years. These costs could be equivalent to all of the profit associated with the launch of a new vehicle and its initial sales. Some of the costs include liability, training, medical testing, lost opportunities in recycling, disposal and need for overdesign.

This analysis was initiated in 1993 and currently is 40% implemented. The analysis is being phased in concurrently with the introduction of new vehicles. Originally DaimlerChrysler asked 250 suppliers to identify hazardous substances to 1 part per million (ppm) and to solve problem areas in their own operations. The suppliers were then unable to pass on the cost along the supply chain to DaimlerChrysler.

Currently there is a 'strategic standard' that the suppliers are required to follow whereby they will be responsible for impacts and problems from their materials from the present time and up to ten years

in the future. DaimlerChrysler, with the aid of an external consulting company, has already put together its own list of materials that it anticipates will cause problems by 2010.

Design for Environment (DfE)

The Design for Environment (DfE) department develops integral vehicle concepts. Its objective is to improve environmental acceptability in an objectively quantifiable way, while at the same time meeting the requirements of the increasing number of customers who pay attention to such environmental aspects as reducing fuel consumption and emissions or using environmentally compatible materials.

One important tool in the work of DfE takes the form of Life Cycle Assessments (LCA) of components or entire vehicles. An ecological Life Cycle Assessment takes account of every last element of the product life cycle – from extraction of the raw materials via production and service life to recycling and disposal. LCAs consider such factors as primary energy consumption and carbon dioxide and pollutant emissions, allowing the developers to compile a precise estimate of the environmental impact of a future product. An LCA for a complete vehicle will include an assessment of this kind for every component.

Conserving resources starts with the selection of raw materials of minimum toxic potential and ends with the recycling or environmentally acceptable disposal of end-of-life components. Wherever possible, DaimlerChrysler uses top quality secondary raw materials in place of expensive and precious primary raw materials; in the plastics sector, preference is given to recyclable materials. Increasing amounts of fibers from renewable resources are also being used – flax, jute or sisal, for example.

No less important is the development of recycling technologies and the planning of disassembly and recycling processes. Only a few years ago, scrap components from passenger cars and commercial vehicles frequently ended up on the landfill, because sorting and segregation was too complicated and expensive. With the advent of the Mercedes Recycling System (MeRSy) in 1993, all that changed. MeRSy has brought a continuous increase in the proportion of scrap parts that find their way back into the materials cycle – from 7,500 tonnes in 1993 to a current level of 13,200 tonnes.

Today, recycling considerations are taken into account from the development stage onwards. Each new vehicle is designed and manufactured in a way that makes for easy segregation of materials. Bumpers, for example, which used to be made of five different materials are today made of just two – or just one in the case of the A-Class. In addition, designers are careful to ensure that – at the end of its life cycle – the vehicle can be disassembled with ease.¹⁴

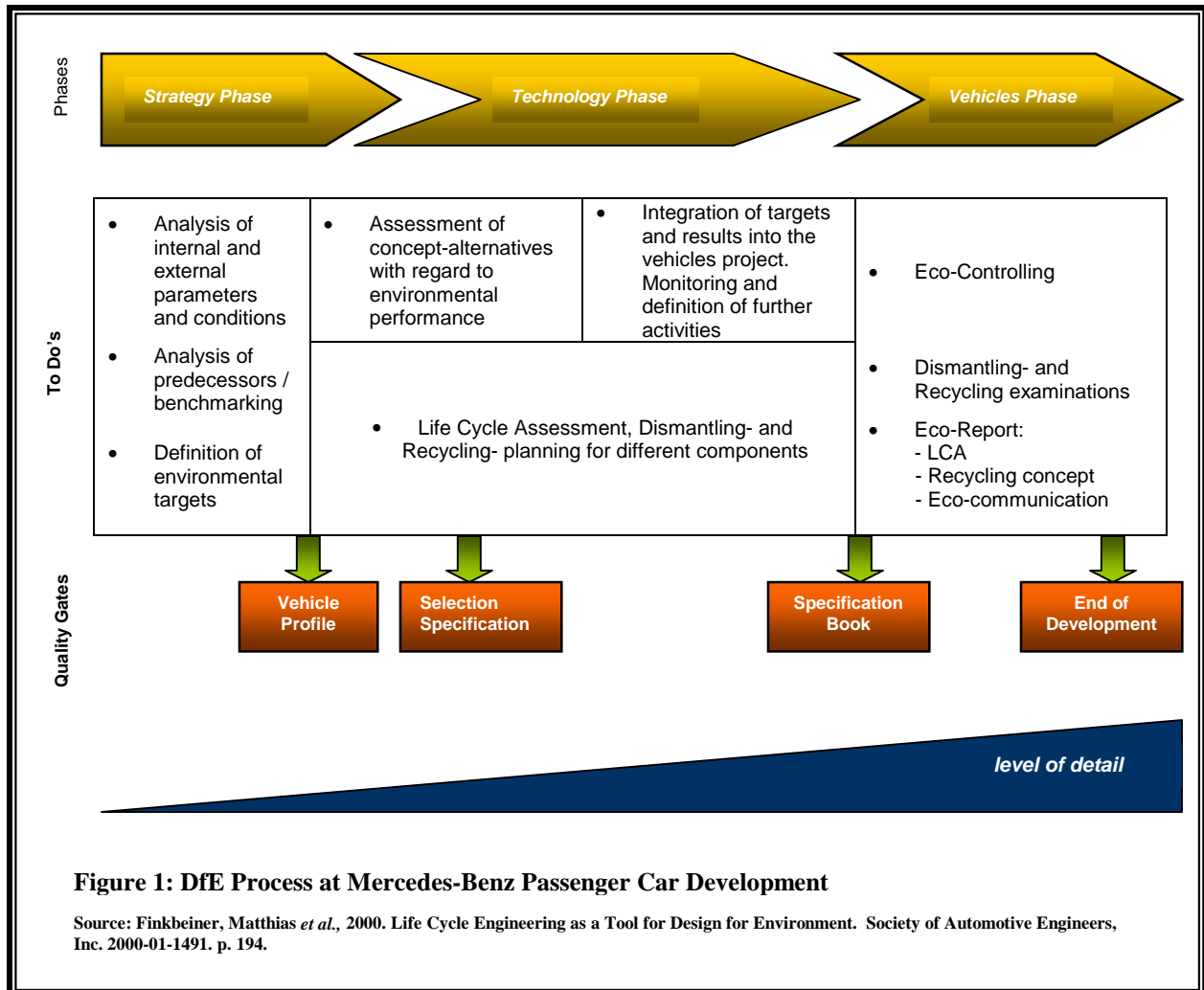
In the past, numerous concepts and tools for DfE have been discussed. However, real and systematic implementation as standard practice in industry has been rather limited for two major reasons:

- Lack of tools for fast and reliable supply of appropriate data and information,
- Lack of practical and efficient concepts for organizational implementation into the development process.

¹⁴ Finkbeiner, Matthias *et al.*, 2000. Life Cycle Engineering as a Tool for Design for Environment. Society of Automotive Engineers, Inc. 2000-01-1491. p. 193.

The DfE concept at Mercedes-Benz solved these issues by implementing a procedure based on Simultaneous Engineering comprising four main elements:

- A methodological procedure, which allows the integration of environmental targets and measures



into the Mercedes-Benz Product Development System. This procedure defines interfaces with developmental phases.

- A formalized PDCA cycle (Plan, Do, Check, Act) to be used as guideline during all development phases.
- Tools and Databases to assist the DfE procedure in evaluating the environmental performance of future vehicles or parts.
- An organizational structure that formalizes the integration of DfE into the Development Process.¹⁵

¹⁵ Finkbeiner, Matthias *et al.*, 2000. Life Cycle Engineering as a Tool for Design for Environment. Society of Automotive Engineers, Inc. 2000-01-1491. p. 193.

DfE Process at Mercedes-Benz

The DfE process at Mercedes-Benz is schematically shown in Figure 1. The figure is simplified, because only four of the actual seven Quality Gates that include the parameter “environmental performance” are shown.

From the very beginning in a development project for a future vehicle, the DfE process starts in the Strategy Phases. During this phase, the overall environmental targets are fixed – based on analyses of the predecessor model and benchmarking as well as further internal and external parameters depending on model and market. The overall environmental targets and improvement options are fixed and documented in the Vehicle Profile.

As the development process proceeds the level of detail of both the vehicle and the environmental targets respectively measures increases. The main activity during this stage (Technology Phase) is to assist the decision-making process in the Product Development Teams by measuring the environmental performance of alternative concepts. Finally, targets, measures and optimization potentials for further development will be fixed and documented in the Specifications Book.¹⁶

Approaching the end of the development process, the main activity is to monitor and control the targets set. Finally, the environmental profile of the new vehicle is documented including e.g. recycling concept, dismantling concept and LCA. Some of this information may be used for communication purposes at the launch of the vehicle, even though the improvement of the environmental performance of the vehicle is the first priority of DfE, not marketing intentions.¹⁷

Performance Measures

Energy reporting is mandatory for all plants to a central authority. Besides energy, waste and emissions are reported, documented and a summary of the measures is published in the corporate environmental report. Those facilities which are certified according to the EMAS scheme, frequently publish their environmental declarations, including energy, emissions waste and water. Reporting typically occurs within the individual plants. Today it is difficult for the DfE group to obtain data from the sites, since they now report directly to their corporate environmental department.

In addition to mandatory measures and reports to the governmental agencies, benchmarking studies are performed both internally and against competitors (including other OEMs as well as other major consumer goods manufacturers) to assess burden per profit, or burden per revenue.

Stakeholder Relations

There is no formal way for third party involvement in DaimlerChrysler’s strategy definition. A suite of tools and “radar” systems are applied to acquire feedback from governments, customers and societal groups. Lobbyists are used to communicate achievements and get the most recent information about policy. Trade associations are also used to communicate and receive information.

¹⁶ Finkbeiner, Matthias *et al.*, 2000. Life Cycle Engineering as a Tool for Design for Environment. Society of Automotive Engineers, Inc. 2000-01-1491. p. 194.

¹⁷ Finkbeiner, Matthias *et al.*, 2000. Life Cycle Engineering as a Tool for Design for Environment. Society of Automotive Engineers, Inc. 2000-01-1491. p. 194.

Customers are frequently asked to evaluate the company's products and their expectations. Neighbourhood programs and other initiatives such as plant visiting days, open museum, as well as the sponsoring of cultural and sport events, provide the means for DaimlerChrysler to communicate with the broader public and to enhance its external relationships.

Company achievements are communicated through scientific publications, press releases, and through active participation of professional organizations and scientific groups. These communications also provide the opportunity for the company to receive new ideas and input from external sources.

Some of the key activities and change at DaimlerChrysler's occurred within the DfE Team, the department of Environmental Strategies, as well as the department of Technology and Research.

Results

Underbody Panel of new Mercedes-Benz S-Class

At least seven different plastics are currently required for a conventional vehicle underbody. One of these plastics is PVC (polyvinyl chloride). For the development of the new Mercedes-Benz S-Class, one of the goals set in the DfE-process was to use as little as possible of this problematic material in order to gradually substitute it with more environmentally acceptable solutions. A new underbody concept has helped to make substantial progress here. It involves replacing the PVC underseal with panels made of glass fibre reinforced polypropylene (PP), which can be fully dismantled and recycled.

To ensure that the environmental burden will be reduced, LCA was used to analyze the concepts. If the effect of the aerodynamic improvement (C_w -reduction) is included, the optimization potential is even larger.

In summary, the PP underbody Panel brings a number of benefits:

- The smooth vehicle underbody reduces noise emissions;
- Lower weight and better aerodynamics cut fuel consumption;
- Production is cleaner, protective measures in the workplace are no longer required;
- Parts damaged in an accident can be easily repaired, scrap parts can be collected by the MeRSy system, and sent for recycling;
- Panels can be made from raw material containing a proportion of recycled material.

For a theoretical production volume of 600,000 vehicles of the current model and a conservative running life of 300,000 km about 1,000,000 GJ of primary energy can be saved and about 57,000 t of carbon dioxide emissions can be avoided. In addition, approximately 6,000t of PVC is substituted, which would end in the ASR-fraction after end-of-life vehicle treatment while the PP underbody panel can be dismantled and recycled.

Other Benefits

Cost savings are difficult to detect, and as such DaimlerChrysler doesn't perform such evaluations. However the company involves cost into decision-making processes, for example with the introduction of more efficient or cleaner technologies. It is always the multi-requirements process, including technical performance, safety, cost and environment that count together. DaimlerChrysler's public records show the environmental investments but do not include the benefits of these investments.

Some of the goals already achieved at DaimlerChrysler include the following:

Environmental Management:

An important goal in 1998 was the integration of plants outside Germany in the Environmental Management System. To support this, a detailed guide to implementation of the Environmental Protection Guidelines and introduction of an Environmental Management System based on ISO 14001 was produced. Along with basic theoretical information, the guide also contains detailed practical guidance and examples. It contains tips for production plants on how to set up an efficient Environmental Management System and encourages an international exchange of ideas.

Hazardous Waste:

In the interests of waste reduction and environmentally acceptable disposal, the *Berlin-Marienfelde* plant (Germany) decided to discontinue saltbath nitriding. Engine parts are now hardened in a state-of-the-art gaseous nitriding facility. This eliminates the highly toxic cyanide waste at source that previously had to be disposed of underground, at great expense. The new technique also has benefits for industrial safety, since it dispenses with the problematic handling, storage and transportation of cyanide salts.

Environmental Training:

To promote environmental awareness and employee motivation, the *Gaggenau* plant (Germany) developed a target-group oriented information and training concept. Under the new system, environmental training courses can now be scheduled at short notice and tailored to the needs of the moment. They also reach employees at all levels and in all divisions. In 1998, 480 employees took part in courses on a range of environmental issues.

Wastewater Monitoring:

In 1998, the *Sindelfingen* plant (Germany) completed trials into biological wastewater monitoring and since 1999 an online monitoring system using luminescent bacteria has been in operation in one of the wastewater streams. The sensitive bacteria give off different amounts of light depending on the substances present in the water and thus serve as a natural early warning system. The more toxic substances the water contains, the less brightly the bacteria shine. The system monitors their condition – and thus the condition of the wastewater – at all times.

Soil and Water Protection:

“Precautions against accidental soil and water contamination” was an environmental goal at the *Gaggenau* plant in Germany. The first step was to conduct a thorough inspection of the entire factory drainage network using modern video technology. Repair of the damage detected has been underway since the beginning of 1999. Work also began on constructing two stormwater clarification basins which also serve as containment basins for chemical spills or contaminated firefighting water. In addition, a new system for automatic detection of pollutants in the drainage network underwent trials and is now in operation at the *Rastatt* subplant, (Germany).

Summary

DaimlerChrysler's eco-efficiency initiatives have been driven by its internal policy, customers' demand for more fuel-efficient vehicles and the global drive for reducing greenhouse gas emissions. DaimlerChrysler has incorporated these market forces into the formation of its strategy and have employed life cycle management (LCM) and design for environment (DfE) in the development of more environmentally sound and fuel-efficient vehicles. This has been done through the use of more innovative materials, improvements in production practices and better design. DaimlerChrysler continues to work on longer-term solutions such as alternative fuels and sustainable mobility systems..

2.4 Shell

Corporate Overview

Shell Canada Limited is one of the largest integrated petroleum companies in Canada. The company produces natural gas, natural gas liquids, crude oil and bitumen and is the country's largest producer of sulphur. Shell Canada is also a manufacturer, distributor and marketer of refined petroleum products. For the year 1999, the company reported consolidated earnings of \$641 million on assets of approximately \$6 billion. Shell Canada has approximately 3,431 employees working across the country.

Shell Canada is a Canadian corporation whose ownership is divided between public shareholders (22%) and Shell Investments (1996) Limited (78%). Shell Investments Limited is owned jointly by a British company, the Shell Transport and Trading Company, (40%) and the Royal Dutch Petroleum Company of the Netherlands (60%).

Shell Canada is made up of 3 main operating divisions: 'Resources', 'Oil Products' and most recently 'Oil Sands'. The Resources division is referred to as 'upstream operations', which explores for and produces natural gas, oil and sulphur in Alberta, Saskatchewan, Québec and offshore Nova Scotia. The Oil Products division referred to as 'downstream', manufactures, distributes and markets refined petroleum products. The downstream operations are located in Québec, Alberta, and Ontario and include products such as: gasoline, diesel fuel, aviation fuels, solvents, lubricants, asphalt and heavy fuel oils. Commercial markets are served by 'bulk' facilities and retail markets through 1,900 Shell service stations and 260 private stations.

Business Context

Shell Canada's parent company, Royal Dutch/Shell, went through a major transformation as a company less than five years ago. In the mid-1990s a number of factors forced Shell to re-think the way that it operated. The combination of the Brent Spar floating oil storage platform catastrophe in 1995, the execution of Ken Saro-Wiwa (a human rights activist) by the Nigerian Government, falling oil prices, increasing global support for action on Climate Change, along with many other incidents involving environmental protests, helped drive the transformation of the Royal Dutch/Shell Group (hereafter referred to as the "Group"). On the positive side the Camisea project in Peru was successful in demonstrating the value of high social and environmental standards. In addition, the entire face of business was changing. Consumers were increasingly demanding information on the products they were using as well as the companies that produce them. The Group's overall strategy is now to contribute to sustainable development and their challenge is to figure out how to make money doing so. The Group began realigning their business strategy according to the principles of eco-efficiency and sustainable development, researching and investing in alternative energy resources and acknowledging the link between the burning of fossil fuels and climate change. The Group's Chairman Mark Moody-Stuart was quoted during an interview, after being awarded the 1999 Tomorrow (a corporate environmental publication) Environmental Leadership Award, as

saying, “By 2050, 50% of energy could be provided by renewable sources. It is perfectly doable, it is just that we forget what a long time 50 years is.”

Pressure is increasing internationally to reduce greenhouse gases by significant amounts. As a part of their Climate Change strategies, companies like Shell and BP Amoco recently began internal emission trading. The future, especially in European countries, will bring market instruments enforced by governments such as CO₂ taxes and the transfer of subsidies away from fossil fuels to cleaner fuels such as solar power and hydrogen.⁶ Those companies that become leaders now in the renewable energy and alternative energy industry will be most successful in the 21st century. By preparing now for the implementation of market instruments and regulations companies like BP Amoco, who have publicly announced their aim to increase their solar energy sales to \$1 billion US by the year 2007, will be the industry leaders. Shell is acting on these pressures in numerous ways, including internal emissions trading programs, implementing best practice social programs in exploration and development projects, and investing in new cleaner energy projects. For example, the Group committed a \$500 million investment to renewable energy in 1998, to be spread over 5 years.

Shell Canada has in fact been made an example by the Group, in terms of how other Royal Dutch companies should operate worldwide, in a safe, efficient manner and according to rigorous environmental policies. Shell Canada’s aggressive approach to integrating sustainability into their core business strategies and producing measures to ensure they are doing so are now being used by Royal Dutch companies worldwide.

Strategy

Sustainable Development

Policy/Strategy

"Shell Canada is committed to sustainable development through the integration of economic and environmental decision-making in its business activities."

In 1990, Shell Canada changed from the more traditional Health, Safety and Environment (HSE) Policy to a Health, Safety, and *Sustainable Development* Policy, as stated above. This first Sustainable Development policy committed Shell Canada to integrating economic and environmental decision-making in to its business activities.

Although there was substantial activity in the early 1990's in sustainable development, the company focused mostly on HSE compliance issues in the mid-to-late 1990's. However, Shell Canada is again focusing on sustainable development. The Health/Safety/Environment department has changed its name from the more traditional HSE designation, which it had held since 1995, to “Health, Safety and Sustainable Development”. This move comes at a junction of several forces including policy, program and personnel initiatives. A new President, Tim Faithful, was appointed from the Group

⁶ TOMORROW Magazine on the Web, Sector CERveillance: Natural Resources Sector: Oil & Gas Exploration - Getting Into Deep Water, <http://www.tomorrow-web.com/natural.html>

and brings with him a fresh and broader perspective. Murray Jones, Advisor, Sustainable Development, returned to Canada in 1999 from Shell International to rejuvenate the long experience-base in the area for Shell Canada. Additionally, the Royal Dutch Group has been active in promoting sustainable development to all subsidiaries around the world, driving them towards better management systems and universal standards of practice. As a result of this renewed focus and commitment, Shell Canada re-wrote its original 1990 environmental policy to be more comprehensive and specific.

Shell Canada's 1999 Health Safety and Sustainable Development Policy:

Shell Canada:

- has a systematic approach to health, safety and sustainable development management designed to ensure compliance with the law and to achieve continuous performance improvement,
- sets targets for improvement and measures/appraises and reports performance,
- requires contractors to manage in accordance with this policy,
- requires joint ventures under its operational control to apply this policy and uses its influence to promote this policy in its other ventures, and
- includes health, safety and sustainable development performance in the appraisal of all staff and rewards accordingly.

In Shell Canada we are committed to:

- pursue the goal of no harm to people,
- protect the environment and pursue the goal of prevention of pollution,
- use material and energy efficiently to provide our products and services,
- develop energy resources, products and services consistent with these aims,
- publicly report on our performance and engage in stakeholder consultation,
- play a leading role in promoting best practice in our industry,
- manage health, safety and sustainable development as any other critical business activity, and
- promote a culture in which all Shell employees share this commitment.

In this way we strive to achieve a health, safety and sustainable development performance that we are proud of, to earn the confidence of customers, shareholders and society at large and to be a good neighbor. We contribute to sustainable development through the integration of environmental, social and economic considerations in our decision-making process.

Implementation

Management Systems

In the mid-1990s Shell developed a system to better manage their health safety and environment issues. The management system is called the Health, Safety, and Sustainable Development (HSSD) management system. The system has been improved more recently to be consistent with ISO 14001, and includes a commitment to continuous improvement of their activities. Each year, Shell Canada updates and reviews its HSSD objectives and targets and reports them in their annual 'Progress Toward Sustainable Development' report.

At this point in time, Shell Canada is about 70% compliant to the ISO EMS requirements, based on a recent gap analysis. By mid 2001, in conformance with the international group requirement, Shell

Canada plans to be fully certified to ISO 14001. The registration plan splits the company into two parts. The upstream business should be registered in 2000 under a single encompassing certificate but with additional plants to be added in 2001. The downstream business will have the first refinery

registered in 2000 with the remaining completed in mid 2001. Other downstream activities will be certifiable but not certified in the current plans.

Assurance Process

The Group has also developed their own assurance process. This process requires the senior manager of each operating unit to sign a letter that confirms that the proper controls are in place for health, safety and environmental issues. The letter that the senior manager signs must address the status or existence of several factors. These include the HSSD policies and their communication throughout the company, HSSD management system implementation, hazard and risk management, emergency preparedness plans, HSE performance in employee evaluation, etc.

Audit Process

Shell Canada conducts full audits of their management system implemented at each facility every four years. Every two years, they perform "mini" audits, which are reduced in scope. The company uses external auditors that audit the facilities against the business units HSSD standards. The senior operating officers in the Oil Products and Resources business units monitor the timely implementation of audit recommendations. In the year 1998, 21 major audits and 10 mini audits were conducted.

Project Assessment

HSSD Assessments, similar in principle to a risk assessment, are done ahead of any new project, large or small. Checklists are utilized, covering a full range of issues from biodiversity to aboriginal considerations to greenhouse gas issues. The process can also include setting each issue, or sub-issues, on ranked scale, in order to guide management considerations for the projects. In order to produce the ranking, issues are weighted according to pre-assigned numerical criteria; each issue is given a numerical 'score'.

When embarking on new projects, Shell Canada uses a number of tools to assess the project according to a number of criteria. These tools are: Sustainable Development Checklist for projects, Sustainable Development Company Evaluation Tool, and the Economic/Environmental Integration Tool.

Sustainable Development Checklist for Projects

This checklist is based on the requirements of the HSSD management system and asks questions to be considered when reviewing projects and to identify areas for potential issues as early as possible. It is required by the company that this checklist must be used during the conceptual design phase of any new project or activity. In addition the verification of the assessment must be documented and maintained.

Areas, called “Potential Contribution Areas”, considered in the checklist are:

- efficient use of energy and resources,
- reduce discharges and emissions,
- preservation of natural environments,
- maximize social benefits and minimize adverse social effects,
- stakeholder involvement, transparency and assurance,
- maximize economic benefits of business activity, and
- include environmental and social criteria in business decisions.

Sustainable Development Evaluation Tool

This tool is used by the company to help get a better understanding of a major project’s potential impacts, whether negative or positive, on sustainable development. It focuses on three main areas – environmental, resource, and social impacts. The tool identifies areas where the company should improve environmental performance and helps monitor progress as a project develops.

This tool also includes a ranking for company projects. Using a series of up to 20 parameters, ‘indicators of sustainable development’, based on HSSD criteria, the company scores each project, assigning it a rank accordingly. These criteria include the need for the project, environmental impacts, etc. and are the same as those used for the checklist above.

The Economic/Environmental Integration Tool

This tool is used to compare different project scenarios and to prioritize projects according to the economic and environmental costs and benefits of undertaking the project. The tool also develops a sort of ‘sustainability index’ to use when prioritizing project options/scenarios. Business units use the tool at the project definition stage when there are potential alternatives available to pursue if an option presents potential negative impacts as a result of the assessment. The sustainability index is similar to the ranking performed above for the evaluation tool. It assigns a score of 1-10 for numerous environmental and economic parameters and this score is then input into a spreadsheet alongside the economic modeling for the project.

Using these tools, Shell Canada can not only detect potential environmental and social impacts, but can also compare alternatives which will be more beneficial economically, by avoiding costs incurred as a result of impacts. In this way, Shell Canada can use these tools to avoid potential costs and to implement only the most ‘eco-efficient’ of projects.

Retail Business Activities

Shell Canada owns and operates numerous service stations across the country. In the past few years, the company has spent approximately \$20-30 million per year on remediation at these stations. In doing so, the company installed a centrally automated system, which monitors the pumps at each station for leakage. The system required local sensors to be placed underneath each pump to detect hydrocarbons or water. If the sensor detects a leak, the pump will automatically shut down and will not restart until the problem is fixed. The benefits of both the general remediation of the stations and the new monitoring system have been significant. Although no dollar figures are readily available,

there has certainly been major cost avoidance as a result of risk management and lower on-going remediation costs because problems are detected and fixed before they can become major issues.

Waste Management

Shell Canada monitors the performance of their waste disposal contractors. Currently, the company is involved in the HSE Auditing group of the Western Canada Auditing Roundtable that shares ideas

on how to better manage waste disposal facilities. With the help of an external consultant, the group has developed a single audit protocol that is used by all member companies to audit waste management facilities, with the goal of assuring compliance with regulatory and corporate standards. In order to reduce costs and time requirements, the waste management facilities now perform the protocol internally, have a third party certified consultant audit the facility and provide a report to member companies. Shell then makes its own decision based on the results. This process saves Shell money and resources because the old process required them to send their own auditors, who would spend 2-3 days on site with the contractor performing the audit. Now, the contractor pays for the third party auditor to come in, but saves money and time because each client used to come to the facility and spend 2-3 days going through various protocols.

Employee Programs

Management Employees

All management employees are included in a program called 'Balancing Priorities'. Employees are evaluated based on corporate principals of: customer focus, growth, HSE, profitability, asset reliability, cost, other employees etc. All managers have a performance contract that is signed annually as a commitment to corporate performance. If employees do not meet these commitments, the company takes disciplinary action.

Operational Employees

All operational and distribution employees are involved in a program called 'Gain Sharing' which focuses on how each site performs according to the principles listed above. Employees will receive a bonus if the site meets all its targets for that year.

Climate Change Activities

Shell Canada has committed to reducing its greenhouse gas emissions to 6% below 1990 levels by the year 2008. Shell feels this is an excellent target, but one which will be very difficult to achieve. Using technologies that increase energy efficiency and therefore reduce emissions is a priority for the company.

The Group has committed to reducing the emissions produced by its customers as well. They are trying to do this in three ways: by increasing the availability of fuels with lower carbon content, by offering renewable energy choices and through researching and implementing new technologies such as hydrogen-powered fuel cell vehicles.

In order to determine the costs of future projects, the Group is using a system called ‘carbon shadow pricing’ to affect the ranking of investment options/business opportunities. Projects that will produce heavy carbon emission loads are economically and environmentally unattractive.

Emissions Trading

The Group has developed an internal emissions trading program to reduce its companies’ long-term emissions and to gain more experience in incorporating the cost of carbon into each company’s operations. The program is called the ‘Shell Tradeable Emission Permit System’ or ‘STEPS.’

Instead of mandating that its entire member companies buy-in to the program, the Group has taken the approach of showing the companies the economic benefits of the program; the benefits of avoiding the costs of carbon. The company feels that this will develop a more serious commitment to the program within all levels of the company. To date, six business units in Annex 1 countries⁷ have committed to the program. These companies include the Group's upstream, downstream and Chemicals core businesses in Australia, Europe and the United States. In Canada only the upstream business is participating at this time. These companies produce 30% of the Group’s emissions and more than half of the Annex 1 companies’ emissions. The Group has developed an agreed upon set of procedures, developed with outside consultants, which will be managed by Shell’s electricity and gas trading organization, Shell Energy. The program commenced in January 2000 and will continue until 2002. An external advisory panel will be used to monitor the performance and efficiency of the system during that time.

Objectives

The Group lists the following as their objectives regarding the STEPS program:

1. Demonstrate the feasibility and merit of international emissions trading as a low-cost way to reduce GHG emissions.
2. Gain valuable, practical experience in emissions trading so that Shell will benefit if trading systems are used in compliance regimes.
3. Identify least-cost opportunities for emissions reduction in Shell when compliance becomes mandatory.

Shell is hoping that one of the outcomes of the system will be to determine the costs of abating GHG emissions. In order for the Group to be proactive and avoid future potential costs, the company will use this information to help develop a cost-effective strategy and plan.

System Structure

STEPS is using a ‘Cap-and-trade’ system where the company sets a quota consisting of an agreed upon aggregate emission level. This level is lower than in the absence of environmental regulation and is based on 1998, because this was the most recent year for which the Group had verified

⁷ A country listed in Annex 1 of the United Nations Framework Convention on Climate Change (UNFCCC). This annex contains names of Parties to the Convention that have market-based, industrialized economies or have economies in transition to the market system.

accurate emissions data. The STEPS emissions target was set at 2% less than 1998 emissions, which is 500,000 tonnes of CO₂ equivalent emissions. Trade permits represent the right to emit 100 tonnes of CO₂ equivalent annually each; Shell is including CO₂ and methane (CH₄) in STEPS trading.

Permits were allocated to companies based on their 1998 baseline emissions. Early auctions were held using 5% of the permits to encourage companies to come to the market and define their trading strategy early in the program.

At the end of each year, companies will report emissions to the Trading Manager, Shell Energy, and remit the equivalent number of permits. If emissions are lower than its permit levels, they may bank the emissions for future years. If the year end shows that a company does not have enough permits for their reported emissions, the Trading Manager will fine that company three times the average fourth quarter trade value for each of the permit shortfalls.

Performance and Verification

Measurement and reporting of participants' emissions will continue using the HSE management framework and systems all Group companies have in place. For Shell Canada, the aforementioned HSSD Management System coupled with specific plans and reporting requirements will be used to manage their emissions, including continuing to report data on emissions in Shell Canada's annual 'Progress Toward Sustainable Development' report and the Voluntary Challenge and Registration system. All data reported and monitored by each company participating in the STEPS program is externally verified for accuracy and quality and is reported according to the Group's HSE Performance Monitoring and Reporting protocols. Using this protocol and each companies HSE management system, participating companies will report their emissions information every quarter.

Products

Shell Canada released two new products in its 'Nautilus' lubricant line in 1998. The lubricants are designed for two-cycle marine engines and carry the Canadian Government's Environmental Choice 'Ecologo' symbol. The products are Nautilus Biodegradable Bilge Cleaner and Biodegradable Boat Cleaner. The Nautilus line also contains the first marine oil in Canada to receive the ecologo label.

Results

As a result of a long-term commitment at Shell Canada's Refineries, the company has realized an 11.5 to 12% improvement in energy efficiency since 1990. Shell Canada uses the *Solomon and Associates Energy Intensity Index* (EII) to measure energy efficiency. The index takes into account increases and decreases in production and is used by refineries around the world. In 1998, refinery energy efficiency improved by 1.7% over 1997 and 6.1% from 1994 levels. Shell Canada attributes the improvements in 1998 to more efficient operations as a result of the management systems in place, which have increased throughput significantly, and also a major upgrade at the Sarnia crude unit in 1997. In general, the company has experienced a \$20 million improvement annually, to which they feel the HSSD management system is a significant contributing factor.

Overall, the company also feels that their comprehensive environmental management program helps them control loss and costs and to avoid accidents at refineries and operating stations. 'Control' was

perhaps the most prominent benefit discussed by Shell Canada when discussing the HSSD management system and its associated programs and activities. The company believes that this improvement has allowed their performance to become superior to past years. In addition, this has helped to improve employee morale at the company's operating sites. The employees not only

feel more comfortable due to increased safety and monitoring, but are also confident due to the level of activity and improved performance regarding environmental issues.

Overall Challenges

A recurring challenge is training and awareness in HSSD. Shell also noted that trying to 'keep the momentum' necessary for the continuous improvement focus of the HSSD is a challenge, because the company is now in the 'maintenance' phase of the loop. As a result, Shell Canada has committed a great deal of management focus and attention to the system, to ensure that continuous improvement will occur and that focus does not falter.

Meeting the corporate target for reducing greenhouse gas emissions is also a significant challenge for the company, due to increases in production and the new Athabasca Oil Sands project.

Summary

Shell Canada's environmental activities are driven by a combination market conditions, public pressure, internal policies and regulatory drivers such as climate change. The company has shifted focus in the last few years, to a more pro-active style of operation. From the detailed project assessment tools the company uses to participation in The Group's STEPS emissions trading program, the company is working towards becoming a more sustainable company. In addition, such efforts will help Shell Canada to avoid costs in the future. Perhaps the greatest challenge for Shell Canada, and the industry in which it operates, is discovering and capitalizing on new market opportunities in the alternative energy sector to replace the fossil fuels market. The oil & gas industry is changing rapidly and companies like Shell will continue to prosper only if their focus shifts to cleaner, safer sources of energy.

2.5 Canfor Incorporated

Corporate Overview

Canfor is a Canadian forest products company based out of Vancouver, B. C. At the end of 1998, the company had approximately 5,030 employees; 3,850 directly and 1,180 through its affiliated companies. The company holds significant woodlands operations and manufacturing facilities in British Columbia and Alberta and has a lumber remanufacturing plant in Washington. Canfor is a major producer and supplier of lumber and bleached kraft pulp as well as many other pulp and paper products. Canfor's market place is global, with offices in Canada, Europe and Japan.

Corporate Culture/Environmental History

Management at Canfor has always made it a priority to protect the environment. Part of their reasoning has always been that the public owns the land on which they operate, but the other is that they have always wanted to be a leader in the forest products industry. In the 1980's Canfor feels that it had a very different atmosphere than other forestry companies; other companies did not want to discuss sustainable development or environment, due to the perceived costs it would involve. Canfor, however, felt that environmental programs with business sense would not only help their bottom line, but would help them to maintain foreign market access and keep ahead of the high costs of regulations. In 1988 the company first began to formalize its environmental strategy, and in 1989 began implementing a formal Environmental Management System (EMS) and formal auditing system.

It could be said that the 'environment friendly' corporate climate at Canfor is a result of the companies' two founding families. Two distinguished and successful European families that came to Canada founded Canfor. They brought with them a 'European' corporate culture, one that is considerate of human health and the environment. Canfor's customer base is made up of many European customers who want to purchase environmentally friendly products from responsible companies. In fact, until very recently, Europe was Canfor's major market place for selling pulp.

The company firmly believes that going beyond regulations and maintaining a European attitude towards environmental protection has helped them maintain their competitive position in the marketplace. In the 1980's, the company began using secondary treatment systems, before many other forest products companies, dramatically reducing the emissions released by their operations. At the Howe Sound Mill in the late 1980's the company faced a difficult decision: to rebuild the mill, which was below standards, or to shut it down. They chose the latter and combined with Oji Paper Co., a Japanese company, to form a new partnership to produce pulp in the new mill. The Howe Sound Pulp and Paper (HSPP) mill is located on the South Coast of British Columbia at Port Mellon. The mill produces northern softwood kraft pulp for world markets and newsprint primarily for Japan. The new mill was the first of its kind to be built in the world, heavily influenced by its 50% Japanese owners. Bill Hughes, then president of HSPP, saw that regulations in Europe regarding discharges into receiving waters were steadily becoming more stringent. He felt that it was only a matter of time before Canada would regulate to the same standards, so he chose to go beyond compliance with Canada's then regulations and deal with the organochlorine compounds being

discharged from the mill. When the mill reopened in the early 1990's, the attitude was to prevent pollution, both to avoid future costs and to please their customers who were becoming increasingly environmentally sensitive.

In the early 1990's, the focus on the environment switched from pollution at the mills to forest practices. Customers had been asking Canfor about clear cutting and other forest practices for some years, so Canfor initiated a series of environmentally related discussions with key customers in Europe to talk about their concerns regarding forestry practices. As a result, Canfor was able to deal with their many concerns and strengthen their customer relationships and build new ones, as a result of their reputation for environmental protection. This activity of discussion with customers, and consideration of their needs, as well as the needs of the customers' customers, continues today.

The company maintains to this day that among the greatest business benefits of environmental protection and committing to sustainable development are market access and cost savings. Their unique combination of European philosophy and leadership has helped them to become a leader, not only environmentally, but also in the European marketplace.

In 1998, Canfor, as a company, restructured and the corporate environment and forestry functions were combined. As a result, a single environmental policy was developed and a corporate wide, ISO 14001 based EMS is now being developed for both forestry and manufacturing. Canfor felt that this integration would provide the company with greater efficiency and improved results in environmental management. The company-wide EMS will consist of Forest Practices Compliance Management and the Canfor Manufacturing Environmental Management programs. The company also expects that the EMS will provide the company with a basis for the registration or certification of their forestry operations to other standards such as those of the Forest Stewardship Council and the Canadian Standards Association.

Business Context

The Forestry and Forest Products sectors are currently facing numerous challenges. As a result, numerous companies are extremely active in environmental initiatives, from investment in the recycling of pulp and paper products to the use of ecosystem management principles in the forest. While the European companies such as Stora and Inveresk seem to be leading environmental activities in this sector, North American companies are beginning to follow suit. Leading the way in North America are International Paper, Canfor and Weyerhaeuser.

In Canada, there is unique pressure on forest companies because the forests are publicly owned. Wise companies operating in Canada, such as Canfor, have involved the public in selected decision-making processes as well as using a pro-active approach by integrating ecosystem management principles into their everyday forest management operations.

The sector, as a whole, is feeling increasing pressure from the companies they supply with their products to become certified to sustainable forestry management certifications like the Forest Stewardship Council's Sustainable Forestry standards. Again, the wisest of companies are getting involved with forestry associations to have an influence on the definition of these standards.

Perhaps the greatest and most important pressure on forest companies, however, is pressure from the marketplace to produce forest products certified to eco-label programs such as the Forest Stewardship Councils labeling program. Companies such as McDonald's, Home Depot and

Prudential Insurance are applying strict environmental procurement policies to their suppliers; requiring the products they purchase to contain a certified eco-label.⁸ Governments are also placing increasing pressure on forest companies as a result of green procurement programs and forestry management guidelines.

All of these pressures are forcing the forest products industry to become more innovative and the forestry industry more respectful of the public and the environments in which they operate.

Environmental Strategy

Environmental Priorities

Because the majority of Canfor's forestry operations in British Columbia and Alberta are on public land, the company feels that it is essential that they maintain public acceptance of their forestry practices. This is in spite of the fact that Canfor receives very little economic incentive provided by the governments of BC and Alberta to thoroughly manage a wide range of public forest values. The company feels that the governments' current approach to managing the forests is unsustainable, both economically and ecologically. Canfor feels that changes are needed to both the tenure and stumpage systems to provide companies with the incentive to manage forests for the long-term, according to the principles of sustainability. In 1998 Canfor established a 'Forestry Principles Task Force' who developed a set of 'Forestry Principles' as an extension and elaboration of their Environmental Policy to deal with these issues. The company feels this fundamental re-assessment of their forestry activities was necessary in order to provide security of employment to their employees, support for the local communities where they operate, and adequate returns to their shareholders. These principles help guide the company in decision making, care of the land, sustainability and ecological issues.

Box 1: Canfor's new Environmental Policy

We are committed to responsible stewardship of the environment throughout our operations.

We will:

- Comply with or surpass legal requirements.
- Comply with other environmental requirements to which the company is committed.
- Set and review environmental objectives and targets to prevent pollution and to achieve continual improvement in our environmental performance.
- Create opportunities for interested parties to have input to our forest planning activities.
- Practice forest management that recognizes ecological processes and diversity and supports integrated use of the forest.
- Promote environmental awareness throughout our operations.
- Conduct regular audits of our environmental management system.
- Communicate our environmental performance to our Board of Directors, shareholders, employees, customers and other interested parties.

The goals of the Forestry Principles are:

⁸ TOMORROW Magazine on the Web, Sector CERveillance: Natural Resources Sector: Pulp & Paper - Turning the Page on Pollution, <http://www.tomorrow-web.com/natural.html>

- Canfor will be a global leader in the profitable production of forest products from sustainably managed forests.
- Canfor is committed to the conservation of soil, water and biodiversity and to the maintenance of ecosystem productivity in the forest areas where we operate.
- Canfor will use forest ecosystem management that encompasses entire forest landscapes and that forecasts the future condition of forests for 100 years or more.

In these principles, Canfor commits to operating according to the triple bottom-line of sustainability; using social, economic and environmental values to guide their practices. The principles include a commitment by Canfor to set measurable ecological targets to measure their performance and to submit themselves to independent audits to verify progress towards meeting those targets. Canfor believes that such an approach to the management of their forestry practices will not only help them gain the trust of the public, but also help them take a leadership role in industry, regarding forestry practices. The principles themselves include commitments regarding: ecosystem management, adaptive management, old growth, timber resource, forest land base, health and safety, first nations, communities, and accountability. These principles are used to guide the company in their everyday core business activities.

Implementation

Canfor's Environmental Policy

Last year, in 1999, Canfor re-wrote their Environmental Policy (See Box 1) and replaced their Forest Stewardship Policy with an extensive set of 'Forestry Principles' (as described above). Canfor expects that this new policy will help them to integrate the environment into every activity of the company and also to become more accountable for their forestry operations. The main reasons for doing so were noted by the company as: public demand for accountability from forestry companies, customer demand for environmentally superior products and supplier environmental requirements. Canfor felt that these drivers, combined, created a new need for the company to base the activities of all of their operations on the principles of ecosystem management and the concept of sustainable development. Canfor felt this activity was absolutely necessary in order to remain competitive and, overall, to achieve their goal of becoming a leader in the forest products industry.

Environmental Management Systems

In 1998, Canfor registered its pulp mills and in 1999 Canfor completed the certification of all of its forest operations to the ISO 14001 standard. This included the largest single certification in North America of 3 million hectares of forest. The company plans to have their sawmills at the standard of certification in the near future and will pursue certification if their customers demand it. The two main drivers Canfor cited regarding the implementation of 14001 based EMS' were, and remain, due diligence and liability.

When identifying the significant environmental aspects at each of their operations, Canfor used/is using a region-based system, in order to deal with the unique ecosystems in different regions. The company has also set up 4 regional EMS committees for their Woodlands operations to track how well each region is doing regarding targets and objectives. The regions are: British Columbia Coast, Prince George, Alberta, and the Peace River. Although the company has set corporate targets and

objectives, individual sites set their own targets and objectives based on a combination of addressing their own aspects as well as the corporate aspects.

The company uses the 14001 standard for much more than just environmental compliance. Canfor uses their corporate EMS, designed using the 14001 standard to implement many other goals, including ecological management, sustainable forestry, and sustainable development in general.

Forestry Certification

Currently there is considerable interest worldwide in the development and enforcing of forestry management standards that require third party certification, similar to what the ISO 14000 series of standards offer in the field of environmental management. As a result of this interest there are currently international standards of sustainable forestry management provided by the Forest Stewardship Council (FSC) and national standards such as the Canadian Standard Z808809. Although the specific requirements of these standards are somewhat different, the goal of these certifications is to provide third party verification that forests are being managed in a manner that is both environmentally and economically sustainable.

Canfor supports third party verification and realizes that it is important to their operations in many ways. Third party verification will help Canfor when communicating with the citizens of British Columbia and Alberta (the owners of the forests in which Canfor operates) and with their pulp, paper, and wood products customers. The driver behind this is that it will help strengthen Canfor's relationships with both the public and their customers. In addition, Canfor will benefit from third party verification because auditors will be able to confirm that they are operating in a responsible manner and are interpreting the principles, criteria and indicators in an appropriate manner.

Employees

The company compensates senior managers for improvements in environmental performance, safety and overall performance. Canfor feels that this is an excellent way to ensure that the corporate environmental policies as well as the forestry principles are carried out.

Canfor feels there is a direct link between their consistently high safety records and their employees' morale. This high corporate morale, Canfor believes, directly benefits the productivity of the company and revenue in general.

Other Environmental Activities

Canfor does a number of environmental activities as a direct result of customer demands. One example of this was a Life Cycle study carried out by the company, in partnership with two other companies, on the environmental impacts of producing a newspaper and a weekly magazine.

Customers, especially those in Europe, feel more comfortable knowing exactly where the pulp comes from and how it was produced. In addition, Canfor has also completed Environmental Product Declarations (EPDS) for all of their pulp products to aid them in communicating with their customers, regarding the impacts and 'environmental shadows' of their products. Canfor bases their EPDS on the Terra Choice method and also has each declaration audited and verified by the company.

The LCA study was conducted jointly with Stora - a Swedish forest products company, Axel Springer Verlag - a German printing house, and Canfor. The study examined the life cycle impacts of a daily newspaper and a weekly magazine. The final results showed energy use to be the most significant impact, with fossil fuels being the greatest contributor. The study has been nominated for the German governments' most prestigious environmental award, 'The Environment Prize 2000.'

One of the most important results of the LCA study was that it helped to uncover the complexities of the carbon chain. This has led to on-going research into and discussion of the importance of the forest in the carbon chain, including its impact on climate change.

Results

Prince George Pulp and Paper Mills

Completion of a burner management project for a power boiler at Canfor's Intercontinental Mill in the fall of 1997 and installation of an electrostatic precipitator in 1998 at a total cost of \$10.9 million was projected to increase the boiler's ability to consume wood residue by approximately 28,000 BDt/year. This project will result in reduced burning of natural gas and correspondingly lower fossil fuel GHG emissions of approximately 22 kilotonnes (kt) /year.

Howe Sound Pulp and Paper

Installation of hog fuel presses at HSPP in 1997 at a cost of \$3.3 million has reduced the moisture content in the wood residue burned in the mill's power boiler and improved burning efficiency. With this improvement more wood residue is being used to displace natural gas. Canfor estimates that this should further reduce GHG emissions by 26 kt / year.

Using Sawmill Sawdust and Shavings to Make Pulp

In December 1996 Canfor began trucking sawdust and shavings from their Chetwynd Sawmill to a sawdust digester for the manufacture of pulp. Approximately 66,000 BDt/year of whitewood which was previously burned as a waste is now being utilized to produce a value-added product. In July 1997, a project to separate sawdust and shavings from bark was completed at Canfor's Polar sawmill in preparation for trucking approximately 28,000 BDt/year of whitewood to a sawdust digester to make pulp. The capital cost of the two projects was approximately \$5.4 million, resulting in a reduction of Canfor's biomass fuel GHG emissions of an estimated 146 kt/year.

These projects, among many others, have greatly contributed to reducing the company's annual contribution to Climate Change. Canfor committed to Canada's Climate Change Program under the Voluntary Challenge and Registry (VCR) in 1995 to reduce their GHG emissions to below 1990 levels by the year 2000. The company had already met that target in 1997 and is committed to lowering it further, through numerous fossil fuel reduction projects. Canfor has made it one of their corporate objectives under their EMS to ensure their continued commitment to the VCR to reduce their greenhouse gas emissions; greenhouse gas emissions were identified as a significant environmental aspect.

Business Benefits

Canfor noted several business benefits of their EMS implementation:

- increased efficiency at their operations;
- decreased fines;
- moving towards sustainable development;
- becoming increasingly proactive;
- more holistic/thorough approach to environmental impacts as a company (due to aspects being determined from the corporate level down to the site level);
- improvements in stakeholder relationships;
- EMS has provided opportunity for public input into activities;
- better reputation with NGOs;
- increased market share;
- using the corporate EMS as a framework to manage all environmental activities has given Canfor the ability to better manage and ensure success of individual projects/programs.

Increasing Market Share Through Environmental Protection

Canfor receives a premium on their pulp from many customers, because they are willing to pay for a product they know has been produced in an environmentally friendly manner. This is not always reflected in the list prices paid, but in the discounts applied. For example, pulp producers may give their bulk orders (large order clients) a 10% discount, while Canfor will offer a smaller discount. The company is able to do so, while maintaining customer orders, because of its reputation and ability to prove the pulp they produce is environmentally and technically superior. Canfor believes that the environmental performance of their operations and products enables them to secure lucrative contracts with the more desirable higher-return customers, and allows them to maintain this business during the weaker periods in a cyclical business. This loyalty factor alone is of significant commercial benefit.

Overall Challenges

The greatest challenge at Canfor in recent years has been the volatility and decline of the forestry market. As a result of stumpage fees and low prices per ton, the company has been challenged in many ways in the last decade. They do, however, feel that their EMS will continue to help them achieve greater and greater operating efficiencies and will therefore keep contributing to the bottom line.

Role of the Government

Michael Jordan, Corporate Environmental Manager of Forestry and Environment at Canfor believes that the government's role should be in setting policies which encourage voluntary initiatives in industry. He also feels that partnerships between government and industry can be very productive, such as the VCR program discussed above.

Summary

Public demand for accountability, consumer demands for environmentally superior products and supplier environmental requirements drive Canfor's environmental activities and programs. Their greatest challenges as a company are the volatility of the marketplace, maintaining operation on publicly owned land in Canada and being prepared for the onset of third party certifications on sustainable forestry management.

Their future will be successful if the company can determine how to best balance economy, environment and society. Canfor realizes they must be prepared for the potential ramifications of the FSC Certification standards in order to maintain operation in the future. The company has implemented numerous eco-efficiency projects that have decreased production costs both environmentally and economically. If they can maintain this balance, while continually improving their forestry and social practices, they will continue to be successful in the future.

2.6 Noranda Incorporated

Corporate Overview

Noranda is a leading international mining and metals company with operations and offices in 20 countries. One of the world's largest producers of zinc and nickel, Noranda is a significant producer of copper, primary and fabricated aluminum, lead, silver, gold, sulphuric acid and cobalt and a major recycler of secondary copper, nickel and precious metals. The company employs more than 18,000 people at its operations and offices worldwide.

Noranda is a Canadian company with common shares listed on Canada's major stock exchanges (NOR). Total sales in 1999 were \$6.47 billion, with total assets of \$11 billion. EdperBrascan Corporation is the company's major shareholder, owning approximately 40% of Noranda Inc.'s common shares. Noranda owns a 49.9% share of nickel/copper producer Falconbridge Limited. Falconbridge and Noranda share similar philosophies, but this case study will concentrate on Noranda because Falconbridge is a separate, public company with its own board, management, policies, management systems, objectives and reporting practices.

Noranda operates in four major business sectors within the mining and metals industry: Copper and Recycling, Zinc, Aluminum and Nickel (through Falconbridge). It will also soon be a major magnesium producer through its 80% interest in Magnola Metallurgy Inc. Noranda is the second largest custom copper smelter operator and the largest recycler of electronic scrap in the world. Excluding Falconbridge, Copper and Recycling is Noranda's strongest sector with a cash-operating margin of \$194 million in 1999. Over 70% of Noranda's markets are in North America, but the company sources feed materials on a worldwide basis. Prices for most of its products are set on global markets. Treatment charges and other smelting and refining terms also reflect global competition.

Corporate Culture/Environmental History

Noranda's first corporate environmental guidelines were established over 40 years ago, but the business and environmental pressures the company faced in the 70s and early 80s caused Noranda to change the way it managed environmental issues. Acid mine drainage became a concern in the early 70s, leading to regulations under the *Fisheries Act* and a series of major capital expenditures. By the late 70s, the local mines that supplied most of the feed to the Horne smelter in Rouyn-Noranda, Québec were nearing depletion. Noranda had to abandon the smelter or transform itself into a custom smelter. To become a successful custom smelter required a long-term approach to technology development and smelter modernization in order to improve the competitive position of the smelter. Noranda also needed to respond to mounting scientific and public concern about effects of acid rain on forests and aquatic resources and regulatory pressure to reduce smelter emissions of sulphur dioxide (SO₂). The result was an ongoing series of major capital projects to strengthen the business and environmental performance of the smelter and expand Noranda's recycling activities while maintaining production.

In 1984, Noranda was among the first Canadian companies to establish a formal corporate environmental policy. At the time Noranda was a diversified natural resource company and exercised leadership within the mining and forestry sectors. Noranda's Senior Vice-President, Environment, Dr. Frank Frantisak, gained the support of senior executives including: Alf Powis, Chairman; David Kerr, President and Chief Executive Officer; Adam Zimmerman, President and Chief Executive Officer of Noranda Forest Inc. (now Nexfor Inc.) and Alex Balogh (current Chairman of Falconbridge and Deputy Chairman of Noranda). That policy remains in place with amendments and provided a framework for the introduction of a comprehensive environmental audit program in 1985, establishment of an Environmental Committee of the Board in 1988 and publication of Noranda's first corporate Environmental Report in 1990. In each case, Noranda was among the first companies in Canada or elsewhere to do so. Noranda has continued to publish an annual environmental report since 1990, with the content evolving to include health, safety and social concerns. Numerous awards have recognized the high calibre of Noranda's reports. Most recently, Noranda's *1999 Environment, Safety and Health Report* won the gold award for natural resource companies in a Financial Post competition sponsored by the Canadian Institute of Chartered Accountants and the National Post. Noranda's latest report, its first on Sustainable Development, is published in English, French and Spanish and is widely distributed by mail.

Despite progressive changes and other successful developments, Noranda encountered determined opposition to some proposed projects, including a pulp mill in Australia and a mine in the United States. Those difficulties underscored a need for early engagement of stakeholders and a need to better assess public as well as technical risks associated with new projects in order to make sound business decisions. Noranda participates in the New Directions Group, which brings progressive businesses and environmental non-governmental organizations together. As a result, Noranda is a strong and consistent advocate for non-regulatory approaches that allow businesses to deal proactively with the environment as a strategic priority, anticipating and responding to concerns in a way that enhances environmental performance and competitiveness, rather than reacting to regulatory pressures that increase competitive burdens.

Noranda revised its Environmental Policy in 1994 and developed a set of sustainable development principles in consultation with stakeholders in 1995. The company developed a preliminary set of sustainable development indicators to assess progress in applying its sustainable development principles, publishing the proposed indicators and inviting comments in its 1999 report and reporting progress using those indicators in its most recent report. Noranda is implementing a formal environmental management system called the Noranda Safety, Health and Environment Framework (described below) and recently revised its corporate environmental audit program to place more emphasis on management systems and self-assurance.

Noranda is expanding its Altonorte copper smelter, which is near one of Chile's major mining regions. As Canadian mine production declines and Noranda's Canadian mines approach depletion, the company must assess the future of each of its Canadian metallurgical facilities. A modernization and expansion of the Gaspé copper smelter in Murdochville, Québec was initiated prior to cessation of mining in late 1999. The Brunswick lead smelter in Belledune, New Brunswick has processed a growing proportion of offshore and secondary feed materials over the past decade and is currently developing an industrial plan in anticipation of the eventual cessation of mining at Brunswick Mining near Bathurst, New Brunswick.

Business Context

In 1998, the mining and mineral processing industries directly employed 367,000 Canadians. Of these, 56,000 were employed in mining, 60,000 in smelting and refining, and 252,000 in the manufacture of mineral and metal products. The mining industry is a foundation of Canada's economy. In 1998, the mining and mineral processing industries contributed \$26.5 billion to the Canadian economy, an amount equal to 3.7% of the Gross Domestic Product (GDP). In 1998, minerals and metals exports were valued at \$45.2 billion, representing 14.2% of total Canadian exports. The minerals and metals industry trade surplus was \$1.28 billion in 1998, representing 6.5% of Canada's \$19.6 billion trade surplus. Mining also makes a significant indirect contribution to the Canadian economy. There are approximately 600 companies in Canada that generate at least 30% of their revenues by supplying mining. In 1998, the shares of more than 300 mining companies comprised about 23% of trading volume on the Toronto Stock Exchange (TSE). In 1998, 53% of the Vancouver Stock Exchange (VSE) financing was raised for the mining sector.

The mining sector has been feeling increasing pressure from environmental activists to be more responsible not only when operating mines but when decommissioning mines. Governments will be forced by the public to implement increasingly stringent regulations where mining is concerned. A future threat to the mining industry is the incorporation of decommissioning and reclamation plans into the permitting process. For example, the state of Wisconsin implemented legislation in 1998 that requires companies wishing to mine in the state to demonstrate that they have operated elsewhere for more than a decade without harming the environment and that these sites will not cause harm for an additional ten years after decommissioning.⁹

Pressures related to mine decommissioning and closure are not new, although there has been growing political pressure over the past year. The Canadian industry and governments have recognized the importance of this issue for some time and have cooperated to develop, demonstrate and deploy mine reclamation technology. The Mine Environment Neutral Drainage (MEND) Program and MEND 2000 are examples. Mines such as Louvicourt (Noranda holds a 30% interest through Novicourt) have demonstrated the ability to minimize disturbance and prevent acidic drainage.

Canadian jurisdictions have legislation, regulations and policies concerning environmental assessment and permitting. Mine reclamation is considered at the design stage and appropriate financial assurance can be required in most jurisdictions. There is a transitional issue as mines developed with older technology face new expectations and reclamation standards and unfunded reclamation liabilities. Active companies are meeting the challenge, although it represents a drain on earnings that contributes to low returns on capital. Historical mines are also becoming a political issue as a result of changing expectations. Some were developed or reopened as a result of government efforts to stimulate regional economies or encourage production of certain commodities.

The sector is feeling increasing pressure from the marketplace, particularly from the automotive and electronics sectors, as a result of the increasing evaluation of metals and resulting materials selection lists and bans. Companies such as Noranda must be able to prove that the use of their products is

⁹ TOMORROW Magazine on the Web, Sector CERveillance: Natural Resources Sector: Mining - Undermining Our Common Future, <http://www.tomorrow-web.com/natural.html>

safe and verify that the information they provide to customers is accurate, in order to maintain presence in these markets. The sector is also feeling pressure to reduce their greenhouse gas

emissions and other emissions such as SO₂. Companies wishing to survive and profit in this sector in the future must be implementing programs now to begin to deal with mining's impacts on the environment and human health.

Noranda is seen as an international leader in many respects in this sector. The company's efforts to develop and use sustainability indicators and their projects involving the recycling and re-use of metals are an excellent example of the efforts this sector can make to address the challenges they face.

Strategy

Environmental Priorities

Noranda cites four issues as the greatest challenges to the company's long-term sustainability:

1. **Access to Capital, Markets and People.** The greatest threat to Noranda's business is in the marketplace. Many base metal producers are not generating returns that exceed the cost of capital, constraining new investment. Weak prices and negative sentiment are detrimental factors, as speculators can sell metal for future delivery, invest the proceeds and profit from price declines. A key concern is the adoption by some countries of technical regulations and other non-tariff barriers to trade in consumer products that contain metals, particularly in Europe.
2. **SO₂ Emissions.** This is a major challenge for Noranda's copper business due to the location of Noranda's copper smelters, which achieve a higher level of sulphur fixation than other Canadian copper smelters¹⁸ but a lower level than some competing custom smelters in Europe or Japan. This creates the potential for discriminatory trade actions or market forces to disadvantage Noranda. Competing smelters are close to markets for sulphuric acid, resulting in a positive return for acid due to low transportation costs. Under such conditions investments to decrease emissions can be justified on economic grounds, while for Canadian smelters freight costs can approach or exceed the selling price for sulphuric acid, producing weak or negative returns. The nature of the business led Noranda and DuPont to form a joint venture for marketing and distribution of commodity grade sulphuric acid to improve customer service and economic returns while reducing costs. Noranda has publicly committed itself to achieving 90% sulphur fixation at the Horne and Gaspé smelters in Québec and at the Altonorte smelter¹⁹ in Chile. The company's reports chronicle a series of major capital investments to strengthen the business and increase sulphur fixation. Noranda developed the innovative Noranda Continuous Converter, installing the first at the Horne smelter at a cost of \$55 million. The smelter is commissioning the converter, reducing the amount of matter processed by the older Pierce-Smith converters and assessing the need to modify one or more converters for final desulphurization. A further expenditure approaching \$50 million is anticipated to increase the capacity of the acid plant to process the higher gas volume. Noranda expanded production at the Gaspé smelter without

¹⁸ An exception is Falconbridge's Kidd copper smelter in Timmins, Ontario, which achieves the highest level of sulphur fixation among Canadian copper smelters.

¹⁹ Altonorte's location is more favourable due to strong regional demand for sulphuric acid to be used for copper recovery from oxide ores by leaching, solvent extraction and electrowinning.

increasing emissions by installing a third converter with concentrate injection, and is evaluating options to shutdown the reverberatory furnace. Noranda also announced a US\$160 million project to double concentrate throughput at the Altonorte smelter and boost sulphur fixation to over 90%.

3. **Greenhouse Gas Emissions.** Noranda must constrain greenhouse gas emissions while expanding current businesses and developing a new magnesium business. Metallurgical processes are energy intensive and many of Noranda's competitors are located in countries with less exacting or no commitments under the Kyoto Protocol. Despite substantial increases in refined metal production since 1990, Noranda's total greenhouse gas emissions²⁰ in Canada have remained near 1,000 kilotonnes CO_{2eq} per year due to energy efficiency improvements, increased recycling, adoption of new process technologies and mine closures²¹. As an example, the Brunswick lead smelter now produces almost twice as much refined lead as it did in 1988, with no increase in emissions. Noranda developed a comprehensive emission inventory for Canadian operations and most non-Canadian operations. An internal Kyoto Task Force is reviewing energy conservation opportunities, potential technological improvements and metal production trends. Noranda Aluminum participates with other members of the Aluminum Association in a voluntary partnership with the U.S. Environmental Protection Agency and has reduced PFC emissions by over 90% from 1990 levels. Noranda established an energy intensity indicator to ensure that implementation of Six Sigma²² supports the strategic goal of reducing energy intensity and is committed to early phase-out of sulphur hexafluoride (SF₆), which will be used as a cover gas at Magnola.
4. **Environmental Expenditures.** A fourth challenge is to maintain overall compliance at operations and closed mines while reducing releases, environmental impacts and mine closure costs. Noranda seeks to redirect capital from environmental projects to projects that strengthen the business and improve environmental performance.

Sustainable Development & Environmental Performance Measurement

Noranda developed six sustainable development principles in consultation with stakeholders:

Environment

- *minimize the physical, chemical and biological effects of our activities on the environment;*
- *nurture excellence by promoting environmental education, training and research programs within our workforce and communities;*

²⁰ Including indirect emissions from off-site electrical power generation and direct emissions from on-site fuel combustion and process emissions.

²¹ The Bell, Granisle, Boss Mountain, Brenda, Mattabi, Geco, Gaspé and Heath Steele mines have ceased production since 1990.

²² Six Sigma is a systematic, statistically-driven approach to the identification and elimination of defects that has been successfully applied by General Electric, Allied Signal, Motorola, Dupont, Bombardier's Aerospace Division and others. Noranda is the first metal producer to adopt Six Sigma.

Social

- *foster constructive dialogue with interested parties on the conduct of our activities;*
- *ensure that our activities are sensitive to cultural considerations, employee and public health, and the needs of future generations;*

Economic

- *ensure that our activities maintain the long-term sustainability of resources;*
- *strengthen the financial and competitive position of the Noranda group of companies.*

A key driver for Noranda to develop these principles is that environmental activities have a material effect on capital and operating costs. Balanced application of Noranda's principles will strengthen its economic and environmental performance and competitive position.

The company developed eight Sustainable Development indicators to track progress in applying its principles and reported against these indicators in its recent Sustainable Development Report (See Box 1). Noranda acknowledges that these indicators are new and may evolve in time, but is committed to use these indicators to measure progress towards sustainable development.

Environmental Policy

Noranda's revised corporate environmental policy aligns the company with the principle of sustainable development:

- **STRIVE** to be exemplary leaders in environmental management by minimizing our impact on employees, the public, customers, and the natural environment.
- **COMMIT** to the principle of sustainable development, which means that our economic decisions will not take priority over considerations of health, safety, and the environment.

Box 1: Noranda's Sustainable Development Indicators

1. SO₂ emissions in Noranda's copper business: Reduction of SO₂ emissions continues to be one of Noranda's greatest challenges. Major capital expenditures have been made to reduce emissions. Our target is for our Canadian operations to achieve 90% capture by 2002, a 57% reduction from the 1985 release level. Noranda has set the same goal of 90% capture for the Altonorte smelter in Chile.

2. Metal emissions to air: Our copper and zinc operations release arsenic, cadmium, lead, mercury and nickel in addition to copper and zinc. Noranda previously committed to reduce total emissions of arsenic, cadmium, lead, mercury and nickel from our Canadian smelters and refineries by 80% from 1988 levels by 2008. We are striving to meet or surpass that target by 2002.

3. Energy consumption: Energy use is an indicator of operational efficiency and a measure of greenhouse gas emissions. Noranda committed to improve energy efficiency at our Canadian operations by 1% per year (energy consumed per unit of production) between 1990 and 2000 through the Canadian Industry Program for Energy Conservation (CIPEC). We continue to meet that objective and to search for cost-effective means to further reduce greenhouse gas emissions and energy costs.

4. Minimizing our footprint: Mining activities are inherently disruptive to the land. Noranda tracks the area of land currently disturbed, new land disturbed, and land restored each year, keeping in mind that there will always be a certain portion of disturbed land in active use.

5. Community dialogue: Noranda is committed to fostering constructive dialogue with interested parties concerning the conduct of our activities. In particular the company strives for open dialogue and transparency at the community level. To date, eight of our major operations have established community liaison committees to discuss environment and economic issues. This practice will be extended to all operations whose size warrants the formation of a committee.

6. Safety: To ensure that our activities are sensitive to employee and public health while respecting cultural differences, Noranda promotes the same safety, health and environmental principles at all operations. The company reports safety performance on a consistent basis and have developed internal indicators to assess the effectiveness of health and safety management.

7. Profitable growth: Business must be profitable in order to be socially and environmentally sustainable. Noranda has set a target of 12% return on investment over the full commodity price cycle.

8. Environmental capital expenditures: Noranda's past investments in environmental improvements have resulted in lower emissions. We will continue to make necessary environmental investments, but environmental capital spending as a percentage of total capital expenditures will decrease as we allocate capital to investments that create value while enhancing social, environmental and economic sustainability.

- **DESIGN**, operate and evaluate our facilities to ensure that effective control systems are in place to minimize risks to health, safety, and the environment.
- **IMPLEMENT** site-specific environmental, health, hygiene, safety, and emergency response policies and programs.
- **DEVELOP** product stewardship programs to protect employees, the public, customers, and the environment by providing risk management information on the safe use, transport, and disposal of our products.
- **CONDUCT** regular environmental, health, hygiene, safety, and emergency response audits and implement action plans resulting from those audits.
- **COMMUNICATE** openly and on a timely basis with employees, the public, governments, and other stakeholders on activities involving health, safety, and the environment.
- **REPORT** regularly to our respective Board of Directors on environment, health, hygiene, safety, and emergency preparedness.

Noranda operations take responsibility for implementing the principles of this policy through the commitments and actions of each employee.

Implementation

Environment Health and Safety (EHS) / Environmental Management Systems (EMS)

Until 1998, Noranda's EMS focused on compliance with regulations and internal policies and relied heavily on cyclical, compliance-oriented audits by Noranda auditors. Noranda is implementing a new environmental management system, the 'Noranda Safety, Health and Environment Framework'. The framework is focused on going beyond compliance and is based on the ISO 14001 EMS requirements and Noranda's definition of EMS:

'A systematic approach to environmental management that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining Noranda's environmental policy.'

Noranda's framework integrates safety and health within the management system and provides the flexibility to go well beyond the requirements of ISO 14001. Any future decision to seek ISO 14001 registration will be based on business needs, but Noranda wants to be well positioned for the future in case customers require suppliers to achieve ISO 14001 registration or government policies favour facilities with management systems that have been independently verified.

Noranda has long had a decentralized approach to managing environment, health and safety concerns, with site managers being accountable for implementing corporate policies and achieving specific goals. Prior to the implementation of the management framework, site managers relied to a degree on Noranda's audit program to identify deficiencies. Sites were responsible for development and implementation of action plans to address audit findings and action plans were subject to review by corporate staff, but did not always correct the root cause of the deficiency. Now all site-related environmental management is in the "hands of the operator." Implementation and maintenance of the framework is a corporate requirement and each site must comply with the framework, at a minimum. The onus is on each facility to implement corporate policies, contribute to corporate goals and systematically identify and proactively manage significant environmental aspects at the

site. The management framework is a vital tool to integrate and achieve Noranda's environmental commitments²³ and obligations, including those that may be imposed to implement the *Canadian Environmental Protection Act, 1999*.

ESH Assurance Program

"The emphasis placed on self-evaluations within Noranda's ESH Assurance Process, together with the regular external Noranda management framework audits, will provide the added certainty that our operations are striving to continually improve their performance in all areas of environment, safety and health."

- Ed Villeneuve, Vice-President, Environmental Projects, Audits and Industrial Hygiene

After 12 years of comprehensive auditing, Noranda's environment, safety and health auditing system underwent a major redesign in 1998. The new Environment, Safety and Health Assurance Process uses the SHE management framework as its foundation and was designed to support continuous improvement at Noranda's operations. It was tested successfully in pilot audits at six different Noranda facilities during 1998. The assurance process was developed to address management concerns that consecutive audits under the previous audit program were revealing similar findings in some cases, indicating that the corrective action taken by sites was not preventing recurrences of deficiencies. Corporate guidelines for the development and implementation of all aspects of the new assurance process are available to all Noranda sites. The new audit system is now focusing on the implementation of the management framework, but the focus will shift to performance in the future. Included in the annual audits will be an evaluation of whether the facility has reached or has programs in place to achieve the targets and objectives set within the management framework to drive continual improvement.

To facilitate the implementation of the new auditing system, Noranda has classified operations in three tiers. Tier One operations have existing SHE management frameworks and will be expected to further enhance their self-evaluation procedures, train their employees to conduct these evaluations, and report on results. External teams of Noranda auditors evaluated whether the systems are being properly implemented in 1999. Tier Two operations will begin to develop the elements of a SHE Management Framework and, if necessary, conduct a gap analysis to identify any issues requiring attention. Management framework audits will begin at these operations in 2000. Tier Three operations include sites that are new to Noranda or require support to develop and implement a management framework. The traditional auditing program was maintained for these operations in 1999, as the transition toward the implementation of the SHE management framework continues.

Drivers

Noranda notes the following as drivers for the development and implementation of the new SHE Management Framework:

- Potential for improved environmental performance
- Potential for gaining and maintaining market access
- Potential cost savings
- Increasing compliance
- Improving business continuity

²³ Examples include commitments accepted through the Accelerated Reduction/Elimination of Toxics (ARET) program, the multi-stakeholder Base Metal Smelting Strategic Options Process and Responsible Care.

- Improving overall environmental image
- Reducing labor requirements
- Improving customer relationships
- Enhancing employee morale
- Improving relationships with regulators
- Facilitating commercial, financial and real estate transactions
- Gaining access to more favourable credit terms from financial institutions.

Challenges

Noranda had to overcome two significant barriers to implement the Management Framework:

1. Site manager “Buy In”– It was difficult for site managers to accept added responsibility without added resources and to accept that the company was not imposing unnecessary bureaucracy by requiring the framework to be documented. Implementation of the framework also required extensive employee training.
2. Corporate Priority – Six Sigma is a top corporate priority that limits availability of resources for other new programs.

Solutions

1. Senior management made a formal commitment to continual environmental improvement and underscored the importance of the framework as a systematic means to drive continual improvement. The company also informed staff of research indicating a relationship between financial performance, environmental management and share prices.
2. To align individual and corporate priorities, staff compensation is based in part on implementation of the SHE framework. Site managers are accountable for specific objectives and targets and set environmental, safety and health objectives and targets for their staff.

EHS Committee

Noranda's Board of Directors plays an important role in helping to address the company's environmental management challenges. The Environment, Safety and Health Committee's responsibilities include ensuring:

- that an appropriate and effective environmental and occupational health and safety management system is in place;
- that responsibilities are effectively delegated;
- that the necessary corporate resources are available for effective environmental management;
- that management reports are accurate and complete, and all significant environmental and occupational safety and health matters are reported expeditiously to the Board; and
- that recommendations are made and corrective action is completed in a timely manner to avoid the recurrence of any significant environmental or health and safety problem.

Employee Awareness, Training & Compensation

In the early 1990's, Noranda developed the Noranda Environmental Awareness Training (NEAT) program. NEAT was designed to help familiarize each employee with the environmental implications of his or her work, and to stimulate new ideas for pollution prevention and other environmental improvements. NEAT is based on the conviction that employees must be informed and motivated if the highest standards of environmental performance are to be achieved.

More than 3,200 employees have taken NEAT training since 1994. During 1997, more than 1,200 employees at Noranda's major smelters and refineries completed the training, along with the Company's geologists around the world.

The overall morale of Noranda's employees is very good. Employees are happy that "*the company means business when it talks about environment*", and are proud to be a part of such a company. During the Auditing Program for 1999, employees were interviewed to determine overall morale and how the employees feel they are/can participate in the management framework. If an employee detects a flaw in a system or can identify an opportunity for improvement at a site, she/he can submit an "Action Plan" or a "Request for an Action Plan", and expect results. This is not rewarded with financial incentives but recognition is given via internal bulletins, published regularly, at the individual sites.

Other Environmental Activities

Responsible Care

Noranda is the only mining and metals company in Canada that has joined the Canadian Chemical Producers Association (CCPA) and become certified under the Responsible Care® program for the safe handling and distribution of hazardous chemicals. In 1997, Noranda's sulphuric acid operations in Québec earned Phase I Responsible Care certification, demonstrating that proper systems are in place and are being tracked for measurable progress. The company is currently working on Phase II at Mines Gaspé in Murdochville, the Horne smelter in Rouyn-Noranda and CEZinc in Valleyfield. These facilities will be verified by the CCPA in 2000 to ensure that Noranda's systems are leading to performance improvements. Third-party auditors will evaluate issues such as life cycle impacts and product stewardship. Magnola will participate in Responsible Care. The industrial plan that is being prepared for the Brunswick lead smelter will also lead to a business decision concerning possible participation by the Brunswick acid plant.

Tailings Management

A Noranda employee led a task force that developed tailings management system guidelines for the Mining Association of Canada.

Noranda is a leader in the development and application of improved technologies for tailings disposal. Noranda has implemented an innovative solution to reduce the potential for acid mine drainage as a result of above ground storage of mine tailings containing waste sulphides, drawing on

experience gained at the Louvicourt mine near Val d'Or, Québec²⁴. In 1998, Noranda's Brunswick mine began using paste backfill. This technology combines finely ground, thickened tailings with a cement binder to create backfill that is suitable for use in stabilizing underground excavations. The Brunswick mine previously used crushed, unconsolidated quarry rock and cemented rock fill to backfill voids left by mining. Paste backfill, produced in a new \$21 million plant that began operating in May 1998, reduces Noranda's operating costs by approximately \$0.88 per tonne of ore mined and substantially reduces above ground tailings accumulation. The Brunswick mine produces approximately 2.6 million tonnes of tailings each year. As of January 1999, 67% of new tailings were being used for mine backfill, with the balance going to an existing tailings pond. At the new Bell Allard zinc/copper mine in Matagami, Québec, the same technology will utilize approximately 80% of the tailings for paste backfill.

Recycling

Noranda is the world's largest custom processor of copper and precious metal-based feeds through its smelting and refining facilities in Canada. Of the one million tonnes of feed processed annually, approximately 15% is copper and precious metal-based recyclable material. The versatility of Noranda's metallurgical process and strong working relationships with an expanding network of suppliers to develop innovative recycling solutions, have been key to Noranda's growth as a recycler.

The Horne smelter in Rouyn-Noranda, Québec had recycled copper scrap since the Second World War but reached a crossroads in the late 1970s, when local mines supplying much of the feed neared depletion. The future economic viability of the smelter was in doubt. Noranda did not abandon its employees and physical assets or the community but identified an emerging and untapped source of feed: electronic scrap and other secondary materials containing copper, gold, silver, platinum, palladium and other impurities. Noranda's expertise in smelting and refining complex feed maximizes the value recovered and allows them to manage a wide range of impurities. Noranda now processes recyclable materials at each of its Canadian metallurgical plants in Québec and New Brunswick and Falconbridge does the same in Ontario. Examples include production scrap from the telecommunication, electronic and photographic industries and materials derived from a wide range of used or obsolete products including telephones, personal computers, children's electronic toys, printer cartridges and costume jewelry.

Special receiving, sampling and handling facilities for scrap, including a shredder, were constructed at the Horne smelter in 1984. The smelter now processes approximately 140,000 tonnes annually of recyclable material from around the world. Approximately two-thirds of the volume is copper-bearing scrap sourced within North America, with the balance being higher value complex materials sourced from around the world and containing precious and platinum group metals.

Noranda acquired Micro Metallics of San José, California in 1984 and subsequently built another facility, Noranda Sampling, in East Providence, Rhode Island. In 1996, Hewlett-Packard and Micro Metallics formed a strategic alliance to enhance Hewlett Packard's electronic hardware asset recovery and recycling program. A Metal Separation Plant opened for business in 1998, in Roseville, California, providing Hewlett-Packard and third parties with disassembly, component testing and material recovery services using leading edge technology and proprietary processes. The

²⁴ The Louvicourt mine is a joint venture between Novicourt (45%), Teck Corporation (25%) and Aur Resources (30%), the operator of the joint venture. Noranda is the major shareholder in Novicourt.

plant has the capacity to process 20 million pounds of metal per year and it has been estimated that it will have paid for itself by 2002. Approximately 55% of Hewlett Packard's hardware recycling is sent to the Roseville plant. Each month, the plant takes in approximately two and a half to three million pounds of obsolete Hewlett-Packard and third parties. This is an innovative undertaking which has provided Noranda with an opportunity to generate additional revenue from metals that have already been removed from the earth, thereby cutting the costs of producing new metals.

To increase its lead recycling capabilities, Noranda opened a new lead acid battery plant at its Brunswick Mining & Smelting lead smelter in 1996. The plant processed more than 10,000 tonnes of spent batteries in 1998.

Recycling is a key revenue generator for Noranda and is vital to the success of the Canadian copper business. The company is continually seeking to expand and improve its recycling capability and is actively examining options for processing of electric arc furnace steelmaking dusts. Further investments in electronic hardware recycling remain under review. One barrier identified by Noranda was federal regulations which restrict their access to imported recyclable materials, imposing uncertainty, delay and transaction, freight and insurance costs on Noranda that are not faced by competitors in the United States or Europe.

Climate Change

Noranda is a supporter of the Canadian Industry Program for Energy Conservation (CIPEC). The company has consistently achieved the program's 1%-per-year reduction in specific energy consumption, a ten-year commitment from 1990 to 2000, and has developed a comprehensive greenhouse gas emissions inventory. Noranda's energy consumption per unit of production decreased 11.4% from 1990 to 1997. This number does not, however, fully reflect the improvements made in each of Noranda's businesses.

More specifically, the copper business includes two custom smelters and a refinery. Total greenhouse gas emissions declined 13.8% from 1989 to 1998 while refined copper production increased 12.6%. Greenhouse gas intensity declined 23.5% over ten years. The zinc business includes a zinc refinery and an integrated lead smelter and refinery. At the zinc plant, total greenhouse gas emissions rose 13.4% from 1989 to 1998 while production increased 31.5% and greenhouse gas intensity decreased 13.8%. The lead plant employs a carbothermic reduction process and a thermal refining process, contributing significantly to Noranda's total greenhouse gas emissions. Total greenhouse gas emissions grew 8.4% from 1989 to 1998 while production increased 101%. Greenhouse gas intensity dropped 46.1% over ten years.

In addition to the expected growth of Noranda's operations over the next decade, the company faces a unique challenge at a new magnesium plant being constructed near Asbestos, Québec in partnership with la Société de Financement du Québec. Production will begin with Noranda using sulphur hexafluoride (SF₆), a non-toxic gas with a global warming potential of 23,900. The gas is used throughout the magnesium industry to protect molten magnesium from oxidization during casting. Magnola will initially use over 80 tonnes per year of SF₆ and will release approximately 250 kilotonnes CO_{2eq} per year from a natural gas-fired cogeneration facility, effectively tripling Noranda's annual greenhouse gas emissions to approximately 3,000 kilotonnes CO_{2eq}. After intensive public consultation, Noranda concluded an SF₆ reduction agreement with the Québec

Ministry of the Environment. For the first 18 months of operation the Magnola plant will operate below an SF₆ consumption rate of 88 tonnes per year, decreasing to 36 tonnes per year and phasing

out use of the gas by 2005. The Noranda Technology Centre has evaluated use of SO₂ as an alternative, and that gas will be used as a partial replacement from the outset. Noranda continues to search for a better alternative to allow Magnola to eliminate the use of SF₆.

Results

Cost Avoidance

There are many examples of cost avoidance and potential savings as a result of environmental initiatives at Noranda. The company bases the majority of their cost savings on the cost of non-compliance. Noranda has avoided paying millions of dollars to date and will save many more in the future as a result of their Tailings Management initiatives with the Mining Association of Canada. The company has avoided the cost of several million dollars in past years and will continue to do so as a result of the many eco-efficiency projects and activities that are implemented as a result of the SHE Management Framework. Many of these savings are a direct result of avoiding non-compliance, but will also be a result of avoiding the costs of new regulation in the future, due to the beyond compliance focus of the management framework. The company has also realized cost savings as a result of reduced insurance premiums, because of the ability to show due diligence and the numerous environmental activities that are taking place in the corporation.

Overall Challenges

Three interrelated issues challenge Noranda as a whole: the volatile nature of commodity markets, the proliferation of non-tariff trade barriers and negative perceptions of metals (See Box 2). Each issue has an impact on Noranda's environmental activities.

Noranda joined other members of the Mining Association of Canada, federal government departments, Ontario Power Generation and the Natural Sciences and Engineering Research Council in funding the Metals in the Environment (MITE) research network. MITE is providing improved understanding of sources of metal emissions, transport and transformation processes in the environment and environmental effects. The results should lead to more informed management decisions by governments and industries concerning metal emissions from smelters and other sources, including use of metals in products.

Box 2: Non-tariff Trade Barriers

Noranda has identified the following problems with policies being applied in Europe and elsewhere:

1. Inadequate information for evaluation of metals is available.
2. Approaches are being used which were developed for synthetic organic substances.
3. The risks associated with potential substitutes are not being considered.
4. Measures implemented are more trade restrictive than necessary.

Noranda played a leading role in initiating the Global Mining Initiative, a multi-stakeholder process that will examine and report on the contribution of minerals and metals to sustainable development and assist the industry to identify the changes required to enhance its contribution to sustainable development. A study by the London-based International Institute for Environment and

Development is underway for the World Business Council for Sustainable Development, based in Geneva. Regional consultations will culminate in a global conference in Toronto in May 2002. To date over 20 of the world's leading mining or metal producing companies have committed to support the initiative, including Alcan, Noranda and Placer Dome of Canada.

Role of the Government

All Canadians have a stake in the future of the mining and metals industry, which makes a substantial contribution to Canada's trade surplus, regional economic development, research, innovation and technology development. Many Canadian fabricators and manufacturers also derive competitive advantage from their proximity to metal producers.

Canada has the most open economy among G-8 and OECD countries, and a lack of regulatory discipline on the part of Canada's trading partners also threatens market access for Canadian forest products, agricultural products and manufactured goods. Leonard Surges, Manager of Environment for Noranda Inc., notes that Canadian governments can play an important role in advancing more appropriate methodologies for assessing health and environmental risks and opportunities for improved life cycle management. One such technique is Life Cycle Assessment, and governments and industry need to understand both how it can be used appropriately and how it may be misused. Life Cycle Assessment is particularly relevant to metals, because the benefits delivered to consumers and society by durable, reliable and safe metal-containing products are most apparent when the economic and environmental benefits of recycling are taken into consideration. He feels that the government has a key role in critically examining and challenging the use of tools and methodologies that create a bias against metal use. He believes that Canada needs to support research such as MITE in order to make sound domestic policy decisions, guard against unscientific claims by other countries about the environmental effects of metals and maintain a principled approach to multilateral environmental agreements. Ultimately, the federal government must initiate and sustain trade challenges if necessary to defend Canada's interests.

Surges also feels that there is a need for tax policies to allocate the burden of reclamation expenditures in an equitable manner. It is unfair to expect shareholders to fund reclamation entirely from after-tax retained earnings. The effect of such policies is to slow environmental progress, as company resources are limited. Retroactive application of new standards materially reduces returns and places Canadian producers at a substantial disadvantage in competing for access to capital and ore bodies. He feels not that we should lower environmental standards, but that the financial burden of meeting those standards should be equitably shared. At the same time, Surges also sees an opportunity to encourage other countries to adopt appropriate reclamation standards, regulatory frameworks and accounting standards in order to promote sustainable development and ensure that Canadian producers are not placed at a competitive disadvantage.

Ed Villeneuve, Vice President Safety, Health and Environmental Management believes that the government should provide tangible support for Management Systems and that government should make companies accountable for their implementation and maintenance. Villeneuve also believes that whole industries should be able to set goals for themselves and should forge partnerships with the government regarding environmental activities. He also feels that industry and the government need to involve the community more in policy making and agenda setting.

Summary

Noranda's environmental activities are driven by numerous factors. One key driver is the perception of metals in the marketplace, and how those perceptions affect customer relationships, trade barriers and business continuity. Noranda's eco-efficiency efforts are mostly cost-driven. The HP Recycling program in California was a result of the company identifying new resources; instead of mining the ore out of the ground, they are recovering it from products that are no longer used. This approach has many benefits, including a major reduction in environmental and societal burdens that occur as a result of mining and also a greater profit margin for the company when selling these metals. Their greatest challenges for the future include access to markets, the reduction of greenhouse gas and SO₂ emissions, and the costs of environmental expenditures. By focusing more heavily on the recycling and reuse of metals and applying their sustainability indicators in a meaningful way, Noranda has the potential to remain an industry leader in environmental activities.

2.7 Airbus Industrie

Corporate Information

Airbus Industrie is jointly owned by Aerospatiale Matra, France (37,9%), DaimlerChrysler Aerospace, Germany (27,9%), British Aerospace, U.K. (20%) and CASA, Spain (4,2%). Airbus Industrie is a multi-national, multi-cultural company with its headquarters in Toulouse, France, and manufacturing sites in France, Germany, Spain, and England. With 11 billion US\$ revenue and over 32 000 employees, Airbus is the worlds second largest airplane manufacturer, specializing in large civil passenger aircraft. Airbus is the civil portion of a cross-European strategic industrial aerospace alliance. Only recently did the parent companies decide to make airbus and its military counterpart an independent public company. The Airbus consortium is currently working on the transformation of Airbus Industrie into a joint stock company. This new company will be called EADS and will not include British Aerospace.

The consortium uses Airbus Industrie for only one major product line: civil airplanes with a range in carrying capacity of 90 to 380 passengers. Under development is the A3XX, with a carrying capacity of over 500 passengers – the world’s largest plane. Airbus operates out of its European Headquarters in France and has regional offices in Japan, Singapore, Korea, Russia, China, and the USA

The Airbus A340, a long-distance plane was recently named by Lufthansa, German Airlines “the most efficient plane in its fleet.” The A340 has an average fleet fuel consumption of 3.9 litres (L) of kerosene per 100 km per passenger. In addition, the Airbus A321 has been awarded the most fuel-efficient short distance plane with an average fuel consumption of 5.5 L per person.

Fuel efficiency is a major driver for the clients of Airbus. With the threat of impending taxation on kerosene in Europe (currently kerosene is not taxed, while all other mobility fuels are) this driver will become even more important. Aircraft users are focusing increasingly on low system or life cycle costs.

The civil aircraft market is steadily growing, although in recent years, the Asian economic crisis has had a large impact on corporate activities and decision-making. The market is tight and extremely competitive. Currently, Airbus is No.2 behind the market leader Boeing, however Airbus' market share is continually growing, while Boeing's is currently decreasing. Increasingly, clients are concerned with reducing the on-going costs for fuel and maintenance of aircrafts, so Life Cycle Costing is an important tool for companies in the airspace sector.

Business Context

The airspace sector's environmental activities are driven by a few key issues: fuel consumption, emissions, and noise. Fuel efficiency is especially relevant for two reasons: first, it is a major economic driver; second, it has a major influence in emissions generation. The potential for

further reducing fuel consumption lies in a few key opportunities: increased turbine performance, which is difficult to achieve, as the major criteria are safety and power under strict performance requirements; light-weighting, since most energy is consumed in take-off and landing, where major accelerations are necessary; and, air flow resistance, where recent developments using “shark skin” surfaces have revealed improvement opportunities.

Emissions of concern are carbon dioxide (CO₂) and especially Nitrous Oxide (NO_x) emissions in-flight. The NO_x emissions are released in layers of the atmosphere, where they normally do not reach (at such high concentrations) from earth, and contribute to ozone depletion and an extended greenhouse effect. Thus the reduction of these emissions is of special importance.

Finally, noise is a major concern of airports. Reducing the noise planes produce is especially important. Here again economy and environment go hand in hand, as more and more airports are demanding higher taxes for older and noisier planes.

Future legislative pressure will include fuel efficiency, emissions and noise amongst other factors, such as safety. An airplane manufacturer that is prepared to meet the upcoming requirements has a substantial advantage in the marketplace. Different factors will be highlighted by different countries, thus countries will have different requirements. Countries such as Switzerland and Singapore will ask for low noise planes, whereas in the rest of Europe fuel efficiency and emissions will be the major factors.

The use phase of airplanes has by far the greatest impact on the environment. Thus the opportunities for improvements lie in the design of the airplane by the manufacturer. It is generally accepted that the manufacturer that offers the highest fuel efficiency will have substantial advantages in the marketplace. In the future, carbon emissions will be subject to taxes and to emissions trading, thus this is a significant driver for Airbus, who will try to meet and exceed its client's expectations here.

In the near future, major technological improvements are expected in the areas of material development (light-weight high-strength materials) and production technologies, as well as in surface treatment. As all planes need to be de-coated and recoated for major structural inspections, painting is extremely important.

Environmental Strategy

Environmental Policy & Strategy

Airbus has no formal environmental policy – the environmental policies of the parent companies apply currently. However, they operate very differently from the parent companies and in some situations, contradict the operating policies.

The environmental policy of DaimlerChrysler is the most stringent and is probably the most suitable policy to become the basis for the new company's environmental policy. For the most part Airbus has the same corporate expectations as DaimlerChrysler. Leadership, excellence,

client satisfaction, and open communication are the major elements in the current Airbus business practice.

Business is still the most important driver in Airbus' activities. Regulatory pressure is most threatening to airplane manufacturers regarding safety as opposed to environment. External environmental drivers are not a major factor with the exception of noise requirements, and fuel efficiency, which is a driver for economic reasons. The majority of the environmental drivers for Airbus are internal, in order to achieve a good brand image and reduce liability costs.

The focus of Airbus' vision is leadership with the goal of being the industry leader, with respect to all requirements: cost, safety, reliability, maintenance, lifetime, *and* environmental performance. Eco-Efficiency is not exactly the word Airbus would use internally, however, its concept is intrinsic to their operations. Efficiency is a focus at Airbus and there is a general philosophy that economy and environment are mutually beneficial.

Implementation

Management systems in place are EMAS and ISO 14001 for some of the manufacturing sites. The certification against the EMAS scheme is more popular in Europe. All German sites have or will have the EMAS or 14001 certification by 2003. For the British sites, certification is expected by 2005, the French and Spanish sites have no final agenda yet – this will change after the formation of the new company.

As all partners in Airbus are individually responsible for their sub-assemblies and components, only site-oriented systems are in place. A product perspective would today be too difficult. This may come after the foundation of the new single company.

In the German Hamburg plant, owned and operated by DaimlerChrysler, a team of 15 people is currently developing rules and criteria for environmentally-friendly design. The team is called the Environmentally Friendly Airbus Manufacture Team and has compiled a catalogue of methods and criteria which specify all general design and process conditions required. The catalogue is intended to lead to a set of uniform standards which will be proposed as guidelines to all Airbus Industrie partners. The first product the team has developed is a design checklist, including aspects such as materials, design and production technology.

Typical design requirements on this checklist are for example:

- reduced material variety, which will allow for larger amounts of “standardized” materials to be bought at lower cost, chips and production scrap to be recycled more efficiently, less manufacturing technologies required, increased use ratio for main production equipment, fewer safety standards, reduced documentation and material use/application guidelines, etc.
- design rules such as joining technologies that allow for more effective and efficient recycling during production and end-of-life, but especially through maintenance.

- production technology, which will allow for the use of environmentally compatible processes and auxiliary materials, increases in production efficiency, etc.

Performance Measurement

Frequent reporting (environmental reports, internal reporting) and monthly internal benchmarking characterize the performance measures at Airbus. Reporting occurs internally to communicate compliance with performance targets to decision-makers and the design evaluation teams.

Stakeholder Communication

Customers are frequently informed about recent achievements, and new developments. Clients are also invited to present ideas and discuss their expectations. Clients get continuous support and service to optimize their maintenance and use patterns. In the French and German plants neighborhood programs are in place to deal with noise and local environmental issues.

Champions

All innovations are driven by individuals at Airbus. In an innovative and chaotic area like aerospace champions play an important role. However, no special environmental champions exist, as environmental benefits are considered a result of improvements to operating costs or efficiency.

Results

Business Benefits

The cost savings and revenue generation as a result of environmental improvements are realized by Airbus' clients - airline companies. Clients benefit from Airbus' achievements, as Airbus sees this as a marketing opportunity. Business benefits for Airbus were clearly

identified in areas of increased environmental performance of their airplanes. The following example highlights this: The Airbus A319 consumes more than 30% less fuel than the comparable Boeing 737-200. Per passenger seat, the A319 has a 59% better efficiency. This has major economic relevance, because for the client, the purchase of a new plane can be amortized much earlier, due to reduced costs for purchasing fuel.

An example of internal savings can be achieved very easy. Recently Airbus started to change all signal signs illumination (Fasten seat belts, no smoking, etc.) from light bulbs to light diodes. The mercury containing light bulbs have a lifetime of only 250 flight hours, whereas the diodes last the entire lifetime of the plane. Thus this is an example of not only environmental benefit, but substantial economic benefit as well. A plane, on average, has 1200 such light bulbs, which cost \$3 each. Thus significantly lower (mercury-containing) waste is generated, maintenance costs are reduced and clients' expectations are surpassed.

Environmental Benefits

In all Airbus plants efficiency programs have been in place for many years. Examples of some qualitative and quantitative results are:

- the amount of waste generated during production was reduced by 45% (result with production volume increase accounted for).
- water consumption was reduced by over 50% (again including increased production volume)
- transportation, both by air and by truck, was organized much more efficiently, for the sake of the environment and for good business reasons.
- local noise emissions were dramatically reduced.
- new manufacturing and painting technologies are more environmentally beneficial.

Employee Morale

Elite staff, working on successful products, and achieving continuous improvements in addition to the company being extremely successful in the market, has led to a very high level of employee morale. In addition, Airbus is continually trying to improve its safety performance at its sites.

Relationships with Regulators

Airbus' relationship with regulators is open and constructive. Policy in the four nations of the parent companies has always reflected the belief that airspace technology is a lucrative and prestigious industry. Thus the company has had no major problems in the past, and will probably not in future. As increased economic performance and more environmentally compatible products go hand in hand, regulators may not interfere. The only "threat" is taxes on kerosene, which will hit Airbus much less than its competitors, due to Airbus' current high level of efficiency.

Summary

Airbus is a leading company in the aerospace industry whose operations rely on a market-driven strategy. Although they are currently operating without an environmental policy, the company is driven by their customer's requirements, which happen to indirectly affect the environment. Customers such as Lufthansa are demanding Airbus produce planes with greater fuel efficiency, thereby reducing the environmental impact from emissions during the planes' use. In addition, the requirement for less operating costs have led to the use of parts with longer lifetimes, such as the LED light example described above. In the future, if the new company does utilize the environmental policies and programs of DaimlerChrysler, Airbus will not only be an leader in the design and manufacturing of airplanes, but also in the journey towards sustainability in the aerospace industry.

3. Examples of Industrial Practice

3.1 Kuntz Electroplating Incorporated

Corporate Overview

Kuntz Electroplating Incorporated (KEI), situated in Kitchener, Ontario, specializes in electroplating for the automotive industry. Established in 1948, with 12 employees, it now employs approximately 725 employees in a 300,000 square foot production facility, and is one of the largest specialized platers in Canada. KEI was classified as an SME until recently when the company experienced a tremendous period of growth. KEI's first involvement in voluntary environmental initiatives dates back to the 1970s when they undertook a pollution prevention program. That program involved recycling the chrome solutions they use in their electroplating processes. Their initial motivation was to decrease costs by reduced raw material use.

A Culture of Continual Improvement

KEI's president is a strong visionary and believes that involvement in environmental initiatives that exceed government requirements helps KEI to strengthen their competitive advantage in the marketplace. In addition, throughout the first decade of KEI's environmental initiatives, the vice-president of the company planned and coordinated all of the programs. This strong commitment by top management to environmental initiatives has ensured their success over the past few decades. In addition, KEI employees are involved in a rigorous profit-sharing program. As a result, morale of employees at KEI is excellent and the overall corporate culture is inherently dedicated to continual improvement of their operations.

From QMS to EMS

In November of 1996, KEI became QS 9000 and ISO 9002 certified. Their mission statement with regard to operations is "To be the best at what we do." There remains a common belief in the company that a quality management system, of any kind, is fundamental for success. KEI's major goal, after implementing the quality standards was to continually upgrade their objectives. Arising from this commitment, KEI began pursuing ISO 14001 registration for environmental management in early 1997. Currently the main drivers for KEI's environmental activities include: senior management commitment, a desire to lead the sector, benefits realized by managing quality issues, due diligence, community commitment, more control over risks, and maintaining competitive advantage. Brigitte Lebel, the QMS/EMS Coordinator for KEI, feels that although the company has met its initial goal, saving millions of dollars through various cleaner production initiatives, environmental improvements require an ongoing commitment.

KEI was certified to the ISO 14001 EMS standard in June 1998. The process took 14 months to complete and included the help of a consulting firm to perform the gap analysis and make sure KEI was meeting the requirements. The final system that is now in place for KEI is unique for its excellent integration of 9000 and 14001. Almost all functions of the management systems that can be integrated have been:

- Training, Awareness and Competence
- Communication Policy
- EMS Documentation & Document Control
- Operational Control
- System Nonconformances & Corrective Action
- Internal Audit System
- Management Review;
- Registration Process & Surveillance Audits and
- Continual Improvement Processes.

Planning procedures for environmental impacts and aspects follow a routine similar to quality control. Severity of an incident, probability of occurrence of impact and likelihood of detection and containment follow a Failure Modes and Effects Analysis (FMEA) chart model. The EMS group at KEI felt that the FMEA method for identifying risks was familiar to all personnel already engaged in the QS-9000 implementation. It made sense to use the same tool for environmental issues as for quality.

Specific Environmental Improvements

KEI has undertaken a number of cost saving, eco-efficiency initiatives that have saved them hundreds of thousands of dollars and have helped them become the successful company they are. Two such initiatives are the Nickel Recovery Project (NRP) and a Cogeneration energy project. The NRP includes a contract with Inco Ltd., through which KEI ships an average of 32 tonnes per week of dried nickel-bearing material to Inco's smelting operations in Manitoba. As a result, KEI receives savings from diverting waste from landfill and also receives reimbursement from Inco based on the quality and quantity of nickel in the sludge. In total, KEI has diverted over 13,000 tonnes of nickel-bearing sludge from landfills over the past 8 years. This has resulted in overall savings of over \$2 million due to a significant reduction in both landfill tipping fees at secure/hazardous waste facilities and transportation costs.

The KEI Cogeneration project began in spring of 1997 and is based on new technology that converts approximately 30% of total energy input into electricity. In addition, another 50% of available heat is converted to hot water and steam that can be used immediately for space heating, domestic hot water, process needs and absorption chilling. This project has allowed KEI to switch from relatively high cost electric power as its dominant energy source to low cost natural gas - producing an annual financial savings of 20% or more in the first year. These savings alone will payback the system installation costs by the year 2002, after which the savings will provide annual cost reductions for the operating life of the system.

Eco-Efficiency Pays Off

Lebel was unable to identify many challenges the company has faced when undertaking environmental initiatives. As a result of the strong commitment from upper management and the overall pro-active attitude of the departments of KEI financing environmental initiatives and their EMS has not been a significant issue. The company feels that lack of human resources and time have had an impact on the success and duration of projects at KEI in the past. However, since the company has nearly doubled in size in the last 5 years, there have been more employees dedicated to environmental management. Now at KEI, there are more than 20 employees engaged in EMS activities as a part of their work routine. The benefits KEI has experienced as a result of ISO 14001 and various eco-efficiency projects are numerous, including: substantial cost savings, improved public perception, environmental achievement awards, and operations that are more efficient.

3.2 Saturn

Corporate Overview

Saturn Corporation is a wholly owned subsidiary of General Motors (GM), established in January of 1985. The company produces small to medium sized vehicles designed and produced in the United States and employs approximately 8,000 people. From employee profit-sharing to dent-resistant polymer body panels, Saturn has established itself as an innovative car company.

Environmental initiatives at Saturn have been going on since the company's inception in the 1980's. Environmental protection and the conservation of natural resources is integrated into their core business philosophy. In 1987 the company established a Citizen Environmental Council of 6 local residents to provide input to the company on environmental issues concerning the community surrounding Spring Hill, Tennessee, where Saturn builds its vehicles.

Saturn complies with the GM Environmental Principles, but uses its own philosophy to go beyond the requirements of GM and government regulations:

Saturn will, "meet the needs of our neighbours, the communities in which we live and operate," by "protecting the environment and conserving natural resources."

Saturn has begun implementing ISO 14001 at their Spring Hill Tennessee facility. Their goal is to have the plant certified by the end of 2000.

The concept of eco-efficiency is heavily embedded into the corporate culture at Saturn and is used to guide their everyday operations. Saturn believes that going beyond what the government requires at present will save them money tomorrow. Saturn has undertaken many initiatives that benefit both the environment and their production costs per vehicle.

Many of the environmental initiatives have a direct result on the bottom-line. Saturn has implemented numerous environmental initiatives, which have significantly cut production costs per vehicle. Saturn is also driven by a desire to be an innovative leader in how to do eco-efficiency and gain competitive advantage, both in vehicle production costs and customer satisfaction.

Green Program

Recently, Saturn implemented a new policy that requires the purchase of reconditioned kevlar gloves instead of new ones. The cost savings generated by using reconditioned gloves are estimated at \$200,000 (US) per year, as a result of a significant reduction in landfill and purchasing fees, or approximately \$0.80 per car.

Water Management

Henkel Chemical Management, Henkel Surface Technologies, and members of the Phosphate/E-coat Team in Saturn's Paint Shop analyzed water leaving the phosphate pre-treatment system. The team found the water quality was good enough to use as rinse water in one of Saturn's reservoirs instead of going to drain. This resulted in significant cost savings, reducing the flow to process waste and eliminating the use of city water in that stage of the system. The total savings was \$221,475 or \$0.89 savings per car.

Design for Environment (DfE)

Saturn uses the concept of Design for Environment (DfE) to drive many of their environmental activities regarding the impact of their vehicles on the environment. From safer and more reliable production process, to eliminating the need for painting certain fascias and evaluating the life cycle of their cars, DfE has been integrated into the way Saturn designs and produces their cars. The company feels that making environmental decisions at the design stage is more efficient than after the car has been produced.

Saturn has been able to design-out the Polyvinyl Chloride (PVC) spray coating it used to apply to the underbody or the wheelwells of the S-series spaceframes. As a result, the PVC masking material savings are \$2,505,600 (US) per year and the PVC sealant material savings are \$162,000 per year - a total savings of \$2,667,600 per year or \$10.71 per car. Most of the material savings came from the removal of the PVC material, as well as the masking material being used to eliminate overspray on critical areas of the underbody.

When designing automobiles, Saturn designers made the cars as easy and efficient to disassemble as possible, to help address future potential vehicle end-of-life requirements. In addition, more than 35% of each Saturn vehicle is made from recycled materials such as steel and reprocessed polymers.

Supply-Chain Management

Saturn's Environmental Supply-Chain Management initiatives are driven by 2 major factors: (1) looking at Europe and Japan's automotive industries, Saturn has identified vehicle end-of-life as a responsibility North American automobile manufacturers will soon be faced with, and (2) customers are pressuring the government to implement product content laws and to reduce pollution in general.

In an effort to incorporate the environment at every stage of a Saturn's life cycle, the company has begun a project called "Greening the Supply-Chain". The project is a result of the joint efforts of the Saturn Supplier Partner Council, the U.S. Environmental Protection Agency Design for the Environment Program and the University of Tennessee (UT) Center for Clean Products and Clean Technologies. The mission of the project is to,

"...develop the shared values, business practices and information systems required to dramatically improve the environmental performance of Saturn and its suppliers,

particularly suppliers that are small and medium- sized enterprises (SMEs) with limited resources."

The project is still in the planning stage and Saturn hopes to implement pilot projects over the next 2-3 years to determine how Saturn and its suppliers can best make environmental improvements in the manufacture, use and final disposition of Saturn vehicle components.

Also as part of a related initiative, to aid in data collection and the environmental evaluation of their vehicles, Saturn has been provided with a Life Cycle Assessment tool-developed by the UT Center for Clean Products and Clean Technologies, called the "Life Cycle Design Toolkit". This software program is designed to help determine where the greatest environmental impacts are occurring in the car's life cycle and which design options are most environmentally favorable. The company will be testing the software to determine how best to use it in their environmental management over the coming year.

Recycling

Saturn has also undertaken perhaps one of the first examples of closed-loop recycling of auto-parts in North America. This project was initiated as a solution to the disposal problem caused by painted body panels and fascias. With the help of General Motors research and suppliers, Saturn initiated a technology for painted polymer recycling. The process is used for both Saturn's painted and unpainted polymer scrap and uses an innovative process to regrind and mold the polymers to create new products. Saturn also uses this technology to reuse damaged parts returned to them by their retailers. The parts are collected during normal runs to retailers by their transportation logistics partner and returned to Spring Hill without incurring extra costs.

Conclusion

In general, Saturn has taken an innovative and aggressive approach to environmental initiatives. The company has been very successful in implementing eco-efficiency projects which are innovative, improve their bottom-line and benefit the environment.

3.3 3M

"I am convinced that the successful companies of the future will be those who both understand and practice the concept of eco-efficiency and how it can enhance business operations, contribute to a better environment and improve quality of life."

- L.D. DeSimone, Chairman & CEO, 3M

Corporate Overview

3M is a \$15 billion company with more than 70,000 employees who create, manufacture and sell 50,000 products in 200 countries around the world. 3M employees bring 500 new products to market a year, and nearly one-third of their revenue comes from products introduced in just the last four years. 3M sells into the industrial, commercial, consumer and health care markets and makes such well-known products as Scotch™ Magic™ Tape, Post-it® Notes, health care products as well as fuel cells. According to 3M their products are created with the aim of finding practical, safe, environmentally responsible ways to make life easier and better.

Almost all 3M products result from combining the company's more than 30 core technologies, which span many disciplines. These technologies include tapes, adhesives, non-woven fibers, films, optics, filtration, specialty chemicals and polymers and micro-structured surfaces.

Corporate commitment to eco-efficiency comes directly from the top. L.D. DeSimone, 3M chairman of the board and CEO, co-authored a book on eco-efficiency with Frank Popoff, chairman, Dow Chemical Co., in collaboration with the World Business Council for Sustainable Development. The book is titled: *Eco-Efficiency — The Business Link to Sustainable Development*. It illustrates how businesses can provide the goods and services their customers need, and at the same time reduce ecological impact and contribute to a sustainable future.

Environmental Management & Compliance Performance

By the end of 1998, 20 facilities had achieved ISO 14001 certification and 70 more were in the process of seeking certification. It is the company's goal to have all manufacturing facilities, making products for international sales, ISO 14001 certified by the end of 2000.

Complying with thousands of governmental regulations worldwide and 3M's own rigorous corporate standards is a complex undertaking. Employees continue to work to reduce violations and spills at all operations. In 1998 fines and notices of violation were down from 1990 at 3M sites worldwide. In 1998, the company paid fines worldwide totaling \$84,900 compared to fines in 1990 totaling about \$253,000. 3M had 60 non-fine notices of violation and permit exceedences in 1998, compared to 98 in 1990. Since 1990, both the numbers of reportable spills

and average spill size have also declined; there were 38 reportable spills in 1998, a decrease of 65 % from 1990.

Life Cycle Management Successes

Product responsibility expectations now call for increased consideration of the life cycle impacts of products and movement towards sustainable development. In response, 3M has developed a Life Cycle Management methodology to help business units take a systematic and holistic look at the environmental, health and safety (EH&S) issues pertaining to products. This methodology is used to help business units achieve 3M's Environmental Management System (EMS) vision.

Through its Life Cycle Management initiatives, 3M seeks to identify opportunities arising from superior environmental, health or safety performance, as well as to characterize and manage risks throughout a product's life cycle. Some of the goals of this program include:

- Identifying business opportunities – innovative EH&S solutions for new markets with new customers.
- Obtain marketing advantages arising from superior environmental, health and safety performance.
- Practice appropriate management of product risks throughout a product's life cycle.
- Increase 3M employee protection and satisfaction by minimizing EH&S risks.
- Meet customers' expectations for life cycle information.
- Move 3M towards sustainable development through the practice of eco-efficiency principles.

3M has been successful in achieving these goals as illustrated by the following examples:

- A well-known furniture company turned to 3M for an environmentally improved, fast drying adhesive that would bond well with the various materials used in the manufacture of their reclining chairs. 3M employees worked with the company to create water-based 3M™ Fastbond™ 2000 Contact Adhesive that addresses environmental, health and safety needs related to the use of solvents. Faster drying time means greater productivity and decreased labor costs for the customer. During a 12-month period, the customer reported savings of more than 500 gallons of adhesive, while increasing its chair production by one-third.

In the past manufacturers of small appliances and electronics equipment, including computers, printers, fax machines, televisions and VCRs often found it difficult to recycle the cases from their products. Product labels were incompatible with thermoplastic resins used in the product housings. The labels, which represent about 1% of the plastic, had to be peeled, cut or ground off before the resin could be recycled into high-value products. Manufacturers complained that commonly used labels complicated their recycling efforts.

- 3M worked with research institutes and plastics suppliers to identify polymer compatibility. They examined the life cycle of labels from manufacture to application on customers' products and through the recycling process. After two years of testing materials that had never been used before to make labels, 3M introduced Recycling Compatible Label

Materials. These materials are not only recyclable but also meet printing and adhesion performance requirements. It was found that the labels could also be applied to the automotive industry, in addition to its original application in the electronics industry.

Reduced raw material, labour and disposal costs for customers were cited among the benefits. This was quite significant since more than 2.1 million tons of thermoplastic waste are disposed of annually in Europe alone. The value of recycled material increased, since compatible labels make recycling easier and more profitable by eliminating the need to remove the labels from plastic cases.

Promoting Eco-Efficiency

3M employees are developing fuel cells that could replace fossil fuel powered vehicles. And 3M's light management technologies — including 3M multi-layer films, the world's most efficient reflectors of light — promote more efficient use of energy. 3M believes that applying more intelligence to products can provide more value with less material and energy consumption. One of the most intriguing new applications of 3M technology is so-called "smart tapes." These tapes combine 3M's adhesives and backings expertise with its electromagnetic technologies to encode information on tape. 3M Intelligent Transportation Systems use these technologies on highways to indicate road or lane edges — a first step toward safer, self-steering, hands-free automobiles.

3M inventory management systems and library products are applying this technology to help customers reduce waste and material loss and identify improvement opportunities.

Pollution Prevention

In 1975, 3M developed the voluntary Pollution Prevention Pays (3P) Program, based on the then-novel concept that pollution prevention is both an environmental and a competitive/financial strategy. The 3P program has been successful beyond the company's expectations, and has kept 3M facilities ahead of many regulatory requirements. In just over two decades, more than 4,600 3P projects initiated by employees worldwide have produced total savings of \$810 million while eliminating 1.6 million pounds of releases to air, water and land. 3M's LCM and EMS is built upon a long-standing tradition of pollution prevention.

Reduced Air Emissions

One of 3M's highest priorities has been the reduction of both volatile organic air emissions from the use of solvents in manufacturing and the emissions of particulates. Since 1990, 3M has cut such air emissions 82% through pollution prevention programs and the installation of pollution control equipment at 3M facilities around the world. 3M global operations reduced its volatile organic and particulate air emissions from 200 million pounds in 1990 to 36 million pounds in 1998. One of 3M's primary strategies for continuing to reduce air emissions is the development of solventless technologies. This is a possibility for many 3M products, including many tapes. At 3M Gorseinon, United Kingdom, various types of adhesive tapes are made with a solventless hot



melt technology. At other locations, water-based materials and ultraviolet curing eliminates air emissions, waste solvents and caustic wash materials.

At 3M Nevada, Missouri, employees reformulated two adhesives used in making tape products. These projects eliminated the use of 300 tons of solvents, saved \$360,000 a year in solvent purchases and improved manufacturing efficiency. For these and other projects 3M Nevada won the 1999 Missouri Pollution Prevention Award.

Greenhouse gases, such as carbon dioxide (CO₂) and some fluorochemicals, are also a focus for 3M. Progress has been achieved at 3M through process changes and pollution control equipment. A one-third reduction in manufacturing emissions of greenhouse gases (as measured in CO₂ equivalents) has been achieved between 1995 and 1998. A plan for further reductions is being developed.

Reduced Water Pollution

3M facilities worldwide reduced releases to water from 6.4 million pounds in 1990 to 1.6 million pounds in 1998, a 75% reduction.

Waste Reduction

3M intends to make continuous, long-term progress in reducing its rate of waste generation. 3M's pollution prevention efforts have demonstrated over many years that reducing waste contributes to profitability, quality and efficiency, making 3M even more competitive. From 1990 through 1998, 3M's rate of total waste generation was reduced by 33%. The amount of solid waste 3M sent to landfills worldwide decreased 20% from 295 million pounds in 1990 to 237 million pounds in 1998. 3M employees continue to look for new ways to reduce the generation of solid waste, reuse it in operations and find other manufacturers who might be able to use it in their products. During 1998, 3M's resource recovery activities in the United States recovered and sold nearly \$40 million of equipment, paper, plastics, solvents, metals and other by-products.

Employees at 3M's St. Paul, Minnesota, tape plant developed an extensive process modification plan, which was followed up with the installation of a new, state-of-the-art coating system. With more control points, the new system offers much more flexibility and reduces start-up and operational waste. More than 12 tons of air pollution and 70 drums of scrap waste are eliminated each year.

Recycling Paper and Packaging

By using high-quality, recycled paper and packaging when possible, even though the cost may be higher, 3M has reduced the amount of packaging material used for its products by approximately 178 million pounds over the last five years.

Voluntary Initiatives



3M participates in several voluntary national programs aimed at increasing energy efficiency and reducing greenhouse gas emissions. As a partner in the U.S. EPA's Green Lights Program, 3M improved lighting in more than 25 million square feet of office, laboratory, manufacturing and warehouse space for energy savings of \$4.5 million. The reduced electrical power usage also lowered emissions of CO₂, a greenhouse gas, by 200 million pounds per year. As a charter member in the U. S. Department of Energy Motor Challenge Program, 3M replaced 280 conventional electric motors with high-efficiency motors and installed 50 adjustable-speed drives at its corporate headquarters. These actions, combined with other optimization efforts, resulted in annual power savings of \$823,000 and CO₂ reductions of 14 million pounds.

3.4 Siemens Canada Limited

“Our Environmental Management System has come a long way...and we have, and will continue to derive great benefits from it. It has become a key element of our overall current management and production process and provides a structured approach to new and future strategies.”

- A.L.P. Woolley P. Eng. – Corporate Manager, Environmental Health & Safety

Corporate Overview

Siemens is a fast-growing corporation that has businesses in 190 countries. The company is relatively new in Canada but now has sales of \$2.0 billion, 6,300 employees with 80 offices and 12 manufacturing plants.

Worldwide, Siemens is the 24th largest company, with sales of DM 134.1 billion, (\$100.6 billion Canadian), of which, approximately 8% is re-invested in Research and Development, \$2 million Canadian per business hour of every business day. Eighty percent of the products are less than five years old and patents average 28 per day, worldwide. It is the third largest electrical/electronic company worldwide, with over 443,000 employees. Siemens is active in six core market segments, namely health-care, information & communications, energy and power, industry and transportation and lighting.

Approach

The overall corporate focus at Siemens has been on eco-efficiency for many years. In 1993, a corporate environmental officer was quoted as saying: *“Economy without ecology is irresponsible, ecology without economy is naïve”*. Part of their Corporate Environmental Policy statement reads: *“If we let a coherent ecological analysis inform the way we think and act, this almost invariably produces economic benefits.”* These statements indicate the type of corporate culture Siemens has established and maintained over the last decade of their environmental activities. They use a highly integrated approach to production at their facilities, minimizing the use of resources and the production of waste wherever possible. Furthermore, they have integrated environmental decisions/concerns into their product development process, requiring their designers to use Design for Environment checklists and guidelines for restricted and preferred substances. Siemens also uses Life Cycle Assessment (LCA) for product research and to help inspire innovation in the company. Their approach to product design can be explained by the following quote from their 1998 Environmental Report: *“Environmentally-sensitive product design, which covers the entire life cycle of an item of equipment or an installation, is a classic example of economic benefits resulting from environmental concerns”*.

Environmental Management Systems

The Environmental Management System (EMS) at Siemens is part of a larger “environmental stewardship” program that combines LCA with EMS. After drafting their ISO 14001 audit

protocol in 1996, Siemens then embarked upon a two-year certification implementation plan. Four of their facilities were selected to apply for certification to ISO 14001 in 1998. Siemens now has 37 facilities certified to ISO 14001.

A key benefit of implementing an EMS is the short term cost savings derived from the aspect/impact evaluations. In 1998, the Siemens North American Automotive plant in London, Ontario achieved savings of \$600,000. These consisted of waste reductions and recycling of metals, paper/cardboard, pallets, gloves, cloths, component reuse and delisting of wastes. Landfill costs were reduced in 1998 by 95% over 1994 costs and the recycling rate reached 85.2%. Hazardous waste disposal costs were reduced by 75% over 1994 costs.

Supplier Management

Siemens developed a Supplier Audit protocol, which helps ensure compliance to the environmental goals and programs of customers in the automotive division, especially those dealing with banned substances. Each of the 100 or more parts suppliers to the London facility has received a self-audit program. This package contains a points- oriented audit and Black and Grey lists. Substances on the Black list are not to be part of the component or the process used to manufacture the part. Substances on the Grey list must be identified and a timely plan developed to eliminate them.

The data collected from the aspects/impacts study was used in the development of plant wide environmental goals that addressed identified opportunities to reduce waste and unnecessary materials within the production systems. The next objective is to develop a fully integrated system, for all of Siemens' production processes, which will minimize unnecessary aspects that add cost to the manufacturing process. All incremental costs can be accurately ascribed to each product, including energy requirements.

Product Redesign

The principles of ISO 14040 (international standard for Life Cycle Assessment) and Design for Environment were first used in 1997, with the redesign of Siemens' brushless motor. This motor lasts 10,000 hours (compared to 2,000 for the previous design) and is assembled rather than welded for lower cost manufacture and ease of disassembly. It has a life cycle improvement of 80% in efficiency and environmental impact over a regular fractional horsepower motor and is designed for disassembly.

With the development of the high efficiency cooling fan motors, Siemens is currently developing modules to replace the drives from the engine for both the water pump and the power steering. On a 1200kg automobile traveling at 90kph, an 8% fuel saving is conservatively achievable.

In 1997, the London plant of Siemens won the London Chamber of Commerce Environmental Award and the first Siemens Worldwide Environmental Award for the programs that were developed for the ISO 14001 program.

3.5 Weyerhaeuser

"...Environmental regulations aim at driving pollution from our systems - and pollution is waste! So, if we approach environmental regulations intelligently, our compliance can help us improve our efficiency."

- Jack Creighton, President Weyerhaeuser

Corporate Overview

Weyerhaeuser is one of the largest forest product companies in the world. The company employs 45,000 people, operates over 200 manufacturing facilities, and has operations/sales offices in North America, Asia, Europe, New Zealand, and Uruguay. Weyerhaeuser headquarters is located in Federal Way, Washington, in the United States. The company owns, leases, or licenses over 32 million acres of timberlands in the United States and Canada alone, and its numerous forest products include: softwood lumber, plywood and veneer, bleached paperboard, printing and writing papers, engineered fibre products, containerboard and corrugated packaging. Weyerhaeuser operates under five main divisions: Timberlands; Wood Products; Pulp, Paper, Packaging and Recycling; Weyerhaeuser Real Estate; and Corporate.

Environmental Initiatives

Weyerhaeuser has been committed to protecting the environment since they developed their first environmental policy in 1971. There are two key phrases in their environmental commitment that are key to the performance of their environmental programs and activities in all five divisions:

"Weyerhaeuser's core value of citizenship includes...holding ourselves to the highest standards of ethical conduct and environmental responsibility, and communicating openly with employees and the public....The company strategically manages its environmental performance to embody those values. Employees work to conserve resources; operate efficiently; manufacture quality products; develop long-term partnerships with customers, suppliers, government agencies and the public."

The company's commitment to public reporting and to operate efficiently, while considering the environment are key to the success of their environmental programs, and business in general. Weyerhaeuser pursues eco-efficiency by implementing numerous pollution prevention/cleaner production projects at their operations across North America.

Programs

Weyerhaeuser has committed to implementing EMS that are consistent with ISO 14001 at all of its facilities. Many of their Timberlands operations worldwide have already been ISO 14001 certified. The company has committed to achieving ISO 14001 certification at all of its Canadian Timberlands operations by the year 2002 and to have all of its facilities, company-wide, capable of certification by the year 2005. The main reason for implementing ISO conformant EMS is to ensure that reliable processes are in place to improve the company's environmental performance, as well as to meet regulatory compliance requirements. Additionally, Weyerhaeuser believes that this effort will protect their preferred supplier relationships with key customers, as well as other stakeholders.

In 1992, Weyerhaeuser developed a strategy called Minimum Impact Manufacturing (MIM). The MIM is a core strategy for environmental and economic optimization at Weyerhaeuser, used to help create more efficient, closed-cycle manufacturing facilities. It is an approach that produces high-value products while continually improving process quality and reducing environmental impact. The main drivers behind the MIM strategy are the company's desire to: increase product performance, improve air and water quality, reduce required energy and chemicals and to produce more product with less material. The primary strategies for the MIM program include the following:

- Investigating every facet of manufacturing practices for possible improvements;
 - Optimizing raw-material usage while minimizing fossil fuel and water usage,
 - Using recycled wastepaper to maximize resource utilization,
 - Generating less waste, reducing emissions, eliminating spills and hazardous wastes, and
 - Reusing and recycling materials previously sent to landfills, including using ash from boilers as a nutrient for forest soil,
- Continuously upgrading manufacturing technologies;
- Building partnerships with regulators and standard setting bodies; and
- Ensuring that suppliers and customers share Weyerhaeuser's values.

In addition, the MIM approach uses the tools of Life Cycle Assessment to help identify and measure cumulative environmental impacts of products and processes. This aids Weyerhaeuser in general decision-making and in their strategic economic planning.

Benefits

As a result of the MIM program, Weyerhaeuser produces 2/3 of its own energy supply using innovative techniques such as burning their own wood residuals, which would have otherwise been sent to landfill, costing both the company and the environment. Many of the mills are self-sufficient in energy use, in a few cases producing surplus energy that is made available for nearby communities.

Perhaps the best example of eco-efficiency through MIM at Weyerhaeuser is at the Flint River Pulp Mill in Goglethorpe, Georgia. At this plant, the company produces pulp for plastic diapers. The mill is involved in an initiative with the U.S. EPA called Project XL, created as a result of the Clinton Administration's regulatory re-invention initiatives. The program's mandate is to 'provide regulatory flexibility in exchange for superior environmental performance'. Through a number of process and waste management improvements, the plant reduced the amount of pollution entering the environment significantly. For example, the plant reduced solid waste by 41%, wastewater emissions by 32% and air emissions by 13%, from their 1989 levels. The mill was able to save over \$600 000 in operating and capital expenses in the first year of participation in Project XL and has won numerous awards as a result of the mills continued reduction of its impact on the environment. According to Kent L. Walker, vice-president and site manager of Weyerhaeuser's Flint River Operations, "Project XL has allowed us to install innovative, flexible environmental solutions into our process up front, thereby reducing pollution and avoiding more costly remedies later."

At their Longview, Washington pulp mill, Weyerhaeuser implemented an 'Environmental Incident Tracking System' in order to improve the identification and subsequent resolution of potential environmental issues. As a result, spills at the effluent plant have been significantly reduced, odor complaints have declined and more than 90% of the resulting determined process improvements have been implemented.

In Canada, at the Edson, Alberta Oriented Strand Board Mill, Weyerhaeuser installed a new high-efficiency energy plant. The plant uses biomass to create heat for the mill, which has resulted in a decrease of natural gas consumption by 25% and has also drastically reduced the amount of VOC's and particulate matter emissions produced at the Mill.

3.6 BP Amoco

“We’re doing that not because we alone can solve the problem, but because the business of business is to find solutions and to resolve unacceptable trade-offs.”

- Sir John Browne, CEO of BP Amoco, commenting on the company’s GHG emissions reductions target.

Corporate Overview

BP Amoco p.l.c. was formed in December 1998 from the merger of British Petroleum and Amoco. The company’s main activities are exploration and production of crude oil and natural gas; refining, marketing, supply and transportation; and manufacturing and marketing of petrochemicals. BP Amoco also has growing activity in solar power generation. BP Amoco is one of the three largest integrated energy companies in world. This position was achieved through the company’s sales revenues, market value, petrochemical facilities as well as its oil and gas reserves. Each day the company generates almost three million barrels of oil equivalent production, of which 62% is oil and 38% natural gas. Amoco has well-established operations in 100 countries on six continents, including: Europe, North and South America, Australasia and parts of Africa.

The company has revenues of US \$120 billion of which US\$ 144 million is from solar revenues and US \$10 billion is from chemical revenues. A total of 97,000 people are employed by BP Amoco and involved in exploration in 29 countries production activities in 23 countries. BP Amoco owns and operates nine refineries in the USA and another fifteen spread around the globe. It also owns 25,700 miles of pipeline and 29,000 service stations worldwide.

The corporate headquarters are located in London, England and the company’s exploration headquarters are in Houston, Texas.

Box1: BP Amoco pledges to seek solutions to the climate change challenge in six areas:

- **Controlling Greenhouse Gases:** BP Amoco will seek a better understanding of our greenhouse gases and how they can be controlled. The company’s goal is to reduce its greenhouse gases by 10% from a 1990 baseline over the period to 2010. This goal is on a CO₂ equivalent basis.
- **Energy Conservation:** BP Amoco will seek continuous improvement in its own use of energy, and will encourage its customers, suppliers and partners to conserve energy.
- **New Energy Technologies:** BP Amoco will continue to grow its solar business, and promote efficient technologies
- **Flexible Market Instruments:** BP Amoco will promote the concept of flexible market instruments including emissions trading, joint implementation (JI) and the Clean Development Mechanism (CDM), and seek to demonstrate their potential and viability to reduce greenhouse gas emissions cost effectively.
- **Policy Processes:** BP Amoco will be an active participant in the climate change policy debate; by investigating innovative solutions to reduce greenhouse gas emissions and by contributing to the design of new national and international institutions and processes.
- **Research:** BP Amoco will continue to invest in and support science, technology and policy research.

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As a global energy company, BP Amoco is aware of its contributions to greenhouse gas (GHG) emissions that lead to global climate change and its responsibility to address this issue. As such the company has identified six areas in which it plans to actively seek solutions to reduce its emissions and address the issue of global climate change (See Box 1).

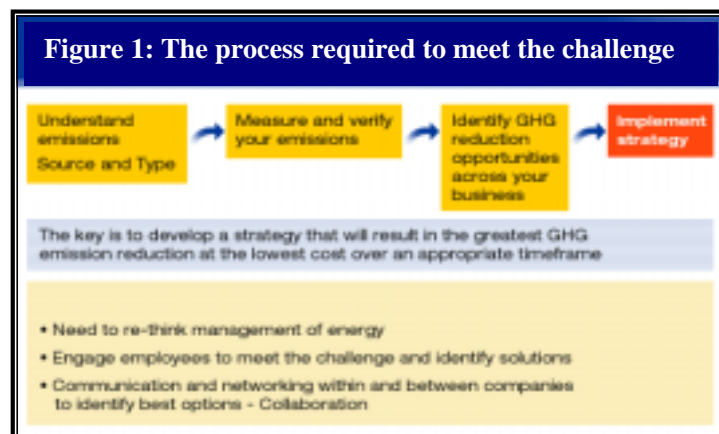
Climate Change Commitment

In 1998, Sir John Browne, BP Amoco’s Chief Executive Officer, committed BP Amoco to reducing its greenhouse gas emissions to 10% below 1990 levels by 2010. The CEO made it clear that this target represents a commitment on the company’s part - one that must be met. In terms on how this is to be met was left open in order to encourage individuals and businesses throughout the BP Amoco Group to use their ingenuity and experience in the most effective way possible.

BP Amoco mapped out a process to help understand the climate change issue, identify actions to address the issue and then implement a company-wide strategy to execute these actions (See Figure 1). The company has adopted a portfolio approach to meet these pledges. Some of the planned action by the company included:

- Controlling its greenhouse gas emissions.
- Engaging in research and policy on climate change.
- Promoting flexible market instruments to ensure reductions of greenhouse gases are met cost effectively.
- Growing renewables businesses such as BP Solarex²⁵

BP Amoco intends to meet its target progressively, year by year and to do it in a way that is transparent. Reductions in emissions will be measured and verified by external experts. GHG target now sits alongside the company’s financial targets and represents its commitment to deliver on this promised target. As the business grows, Amoco will incorporate new activities into the baseline of the calculation and into the overall target.



GHG year,

and The

BP

²⁵ BP Solarex is a global solar electric company that manufactures, designs, markets, and installs a wide range of crystalline silicon and new generation thin film solar electric products and systems for residential, commercial, and industrial applications for remote and grid-connected systems.

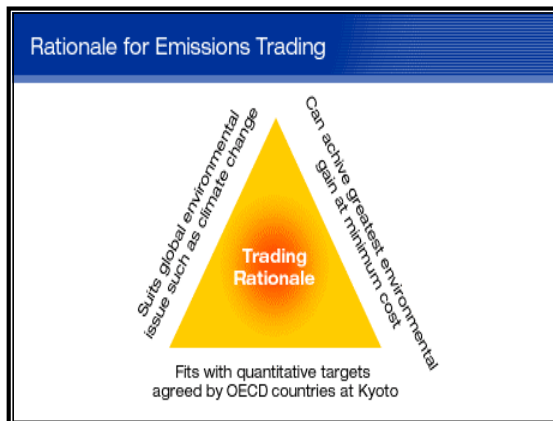
Flexibility is necessary to tackle the issues of greenhouse gas reduction, since it encourages innovation, cost effective solutions and maintains competitiveness. It also makes it easier to absorb and apply new information and new technologies and to ensure that the company's basic approach remains relevant over time. Market mechanisms stimulate flexibility and facilitate better solutions throughout the world. In particular BP Amoco supports the three flexible market mechanisms created by the Kyoto Protocol:

- Emissions trading
- Joint Implementation
- Clean Development Mechanism (CDM)

Market mechanisms can benefit both the developed and developing world by facilitating emissions reductions and enhancing carbon sinks. BP Amoco's involvement (which stretches across the company) in such flexible, market-based mechanisms is key to the company achieving its commitments.

Emissions Trading Pilot Project

An internal pilot emissions trading system had been in operation with 12 former BP Business Units since September 1998, which provided interesting and valuable lessons in emissions trading for BP Amoco. BP Amoco proposed the use of a system of group-wide emissions trading as a central tool to deliver on its commitment. On January 1st, 2000, this system went live on a global basis - the first truly global corporate greenhouse gas emissions trading system was actually put into operation. The new trading system includes all BP Amoco operations worldwide and provides all business units with capped annual allowances. The sum of the allowances represents BP Amoco's annual reduction. This annual cap will be ratcheted down each year to meet the 2010 objective.



Greenhouse gas trading allows business units who can achieve low-cost emission reductions to sell excess emission credits to business units whose reduction costs are higher. Effective verification of the data used in the emission trading scheme is an important element in securing the credibility of trades and paves the way for BP Amoco's involvement in future external trading regimes.

In 1999 BP Amoco commissioned a groundbreaking independent audit and verification of its greenhouse gas accounting and reporting systems. A team from KPMG, Det Norske Veritas (DNV) and ICF Consulting provided independent audit and verification of the company's reported greenhouse gas emissions baselines for 1990 and 1998. The team has developed the first-ever industry greenhouse gas emission audit process consistent with international financial and environmental auditing standards. It is important to BP Amoco that the greenhouse gas audit process takes account of the views of external players and is transparent. In order to help achieve this, the project established an independent oversight team from leading individuals in

government, science and interested NGOs. This Expert Panel provides a focus for discussion and review throughout the project and ensures that the interests of BP Amoco's wider stakeholders are represented.

BP Amoco recognized that the challenge of climate change is best met in partnership with others - governments, national and international agencies, environmental groups and other companies. The company is involved in several partnerships intended to identify the strategies needed for development of low carbon energy sources and greenhouse gas reductions.

One such partnership is with the Massachusetts Institute of Technology (MIT) - The MIT Joint Program on the Science and Policy of Global Change is an interdisciplinary organization for research, independent policy analysis, and public education in global environmental change. It seeks to provide leadership in understanding scientific, economic and ecological aspects of climate change, and to combine these considerations into policy assessments that serve the needs of ongoing national and international discussions.

Emission Reductions Results

At the refinery at Kwinana, south of Perth in Australia, the unit carbon dioxide emissions have been cut by 19% since 1995. This was achieved through the following efforts:

- The refinery commissioned a cogeneration plant in late 1996, supplying all its needs and dramatically cutting emissions;
- The refinery has worked hard to reduce flaring. Since the beginning of 1997 the refinery has reduced emissions from flaring by 55%;
- Renewed effort was put into energy efficiency to cut emissions by a further 27% through reduced consumption of fuel gas, electricity and steam. This was all done in parallel with an expansion to the refinery's production.

The Kwinana refinery, with the assistance of the Western Australian Department of Agriculture, has a unique opportunity to achieve net zero Greenhouse Gas emissions by changing land use and forestry sequestration. This has also been of great benefit to the rural community, because it helped to mitigate soil salinization, which is a significant environmental issue in the area.

Some other emission reduction initiatives include:

- On the Trans Alaska pipeline the company is using drag-reducing technology that means it can cut out a number of pumping stations. The result is an annual reduction of around 200,000 tonnes of carbon dioxide emissions.

- In the UK sector of the North Sea, BP Amoco has made a series of ties network including the pipeline system that takes the oil to shore. The company has progressively cut flaring by two-thirds since 1995. This translates into a reduction of 200,000 tons of carbon dioxide emissions per year.
- Carbon dioxide, recovered from the company's plant at Lavera in France, is used to put fizz into carbonated drinks.
- At Hound Point in Scotland where the Forties pipeline comes ashore, BP Amoco has built a Vapour Recovery project which captures the heavier hydrocarbons emitted when tankers are loading in the Firth of Forth. These emissions would otherwise oxidize to carbon dioxide in the atmosphere. The effect of the project will be to cut emissions by around 100,000 tonnes a year.
- The company's gas business in the San Juan Basin in New Mexico and the Greater Green River Basin in Wyoming is firmly on course to reduce methane emissions by 20,500 tonnes a year, which is equivalent to reducing carbon dioxide emissions by some 432,000 tonnes.

3.7 Beaver Meadow Farm

Background

Farming practices on Beaver Meadow Farm have changed considerably over the last decade. This third generation farm, located on Vancouver Island, was able to harness the benefits of its geographical location and local climate to make its farming practices more energy efficient and financially profitable.

Beaver Meadow Farm practiced a more conventional style of farming throughout the 1960s and 1970s, but was forced to revise their approach. The main driving forces behind this change included the loss of provincial and federal support programs in the early 1980s, coupled with a continual competitive disadvantage with respect to their higher input costs as compared with those of their mainland counterparts.

The majority of the high costs Beaver Meadow was incurring could be traced to energy consumption. Beaver Meadow conducted research and realized that they possessed a geographical advantage in that they had of the solar energy available for 7-8 months of the year, which could be captured by plants. Then they investigated how they could transfer that captured energy into marketable products. They discovered that the greatest value could be obtained through forest production. The very mild climate offered a 10-month growing season, which meant a greater capture and transfer of energy into the product. Approximately 100 acres of the 700-acre farm were converted into a holistic forest operation.

Box 1: Holistic Goals for Beaver Meadow Farms

We will create a dynamic business, securing the basics of life and financial security in an enjoyable, satisfying and fulfilling manner for ourselves, our families and our workers. We will lead healthy nurturing lives full of vitality, love and self-expression. We will have an uncomplicated and balanced lifestyle in tune with nature and the local community. Sufficient leisure time will allow us to accomplish our choice of life activities that include personal development, creative learning and family activities.

By maximizing biodiversity and capturing solar wealth, our profit will come from plants and animals sold through market opportunities.

Our vision is a land diverse in plants and animals with vital producing farmlands, waterways, forests and recreational areas. We will develop a natural aesthetic landscape that enhances water mineral and energy cycles that support our aims of well being.

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Another potential method of capturing this energy was via a permanent forage grass-based pasture, since it was found that a certain density of ground cover could capture similar amounts of energy as a forest. Dairy cattle were the most efficient at transferring the energy of the grass into a marketable product, when compared to other types of animals. So Beaver Meadow concentrated their efforts into dairy production.

Thirty acres of the land was put into cranberry production because this particular crop was also found to be quite efficient in converting solar energy into a marketable product. The cranberry production led to an additional benefit of diversification of income for the farm.

Operational efficiency at the farm is crucial for the attainment of its written ‘holistic’ goals. These goals encapsulate the operational approach and philosophy of life at Beaver Meadow Farm (See Box 1).

Challenges

The idea behind changing from the traditional market style of thinking to a more a sustainable form of farming proved to be a challenge. The employees of Beaver Meadow Farm greeted the new approaches with little enthusiasm, as they had to learn new skills and change what many of them had been doing for 15-20 years. The farm’s attempt to practice this form of farming within a more traditional farming community was met with little support.

All of the research done on maximizing the incoming solar energy on the farm and how to efficiently convert this energy into a viable product were all done internally through independent study. Access to relevant information was a limiting factor, since specialized information, such as the energy conversion for certain crops, was not readily available.

Similarly, there were limited available resources present to deal with problems that resulted from these ‘new’ practices, such as cows getting sick from eating green grass.

There are approximately 800 dairy farms in B.C. but only 12-15 biological/organic farms, and they are often viewed as a nuisance or a problem for the traditional agricultural system because they require more flexibility. For example, the B.C. milk marketing board utilizes a milk quota system that penalizes farmers that either exceed or produce below the set quota. This approach was at odds with Beaver Meadow’s practices, which resulted in greater milk production during favorable soil and weather conditions and lower production during bad weather. As a result of the inflexibility of the system, and the inability of the system to adapt to ‘sustainable biological farming,’ Beaver Meadow was often penalized and lost money.

Regulatory approaches, such as the Fisheries Act and the Water Act, were also very rigid and were not compatible with biological sustainable farming. Hence a lot of time was spent explaining the different approaches to officials, trying to educate them about the sustainable approach and a need for flexibility when dealing with government regulations.

Benefits

Dairy grazing is a core enterprise on the farm, comprising about 75% of total operation. The approach used at Beaver Meadow is to “mimic nature’s way of doing things.” The cattle are managed in a manner that imitates the essential elements of a herd of grazing buffalo. As a result there is no need for barns, bedding or expensive grain during the grazing season; manure spreading is done by the animals themselves as they move around, less fuel and less machinery is required; and the need for pesticides and herbicides has disappeared. This all translates into an enormous amount of cost-savings.

Since 1980 Beaver Meadow Farm has experienced a decrease in the cost of milk production between 25-30%. The expertise of the manager was enhanced and it also removed much of the production costs that otherwise would have been present.

In the first 10 years of production the Farm's products were processed by and marketed through co-operatives. In the last few years however, Beaver Meadow partially removed itself from the co-operatives to get a premium return on their (now certified 'natural') products. Currently Beaver Meadow is in the process of certifying forest products, and in the last stage of certifying dairy products.

Soil fertility and water-holding capacity is continually improving. Over the last 20 years, more carbon is sequestered per acre, increasing the content of organic matter. The percentage of soil organic matter often exceeds 30%.

Farming on Vancouver Island underwent 15 years of duress, however production on Beaver Meadow Farm remained unaffected mainly because their approach enabled them to compete in the changing marketplace.

Beaver Meadow Farm feels confident that the changing climate of the coast of B.C. would be easier for them to adapt to, since they project that they would experience less crop failure than the conventional farm since the types of crops being grown could readily adapt to these changes.

Employee morale has improved as most employees enjoy their new roles. They are an integral part of decision-making, and work within a safer environment.

Beaver Meadow considers the community support being experienced at present, to be one of the biggest benefits they have. The community actively shows its support by turning out to municipal meetings to oppose any zoning or planning process that would adversely affect Beaver Meadow Farm. Support also comes in the form of positive representation by government agencies (such as the Department of Fisheries and Oceans) and other agencies that are involved at some level with the farm.

Other Initiatives

In order to protect the hundreds of Trumpeter Swans that winter on the farm, Beaver Meadow and Ducks Unlimited put together a winter management plan. These birds were initially seen as enemies since they destroyed the grazing pasture for the cattle and caused approximately \$200,000 worth of damages.

Beaver Meadow Farm also operates a salmon enhancement program whereby they raise between 200,000 and 300,000 salmon in the farm's waterways. There is a diversity of species including Coho and Chum Salmon as well as Cut-Throat Trout. None of the fish are harvested.

3.8 Alcan Aluminium Limited

The Company

Alcan Aluminium Limited is a major integrated metals producer that has employed life cycle management (LCM) approaches since the late 1980s. A Canadian-based transnational corporation whose operations around the world include mining, refining, smelting, metal finishing and recycling, the company has annual revenue of approximately \$8 billion.

At Alcan Aluminium Limited life cycle management is central to the Product Stewardship Program, which runs in parallel to, and complements the corporate Environmental Management System. The stewardship program is product-focused and integrated across the organization. It includes design, market-support and pollution-prevention strategies.

As a materials supplier, the life cycle focus has been on product understanding and downstream market support. Approaches used included life cycle assessment (LCA), life cycle inventories (LCI), Design for Environment (DfE), and customer consultations.

Discovery of LCM

Alcan Aluminium Limited's first encounter life cycle management (LCM) was in the European market in 1988, where negative from competing materials interests were being against company products. These raised concern and required an immediate and concerted response. The claims were based on inaccurate information and were misrepresenting the environmental performance associated with materials, thus damaging Alcan's product value in the market.

Life cycle assessment (LCA) was used to develop a structured and successful defense to claims. A product-focused environmental analysis was performed, leading to information describing environmental aspects of metals products. The results of the study were used selectively: to inform communicators within company, and to help support and maintain customer relationships.

Summary of LCM in Alcan

Key Barriers

- Absence of standardized protocols
- Weak linkages between economic and environmental life cycles

Key Accomplishments

- Established links with customers
- Reduced costs in operations
- Reduced cost of products
- Supported government communications
- Supported existing business.

Key Challenges

- Consistent application of management systems
- Capitalizing on the environmental value of products through the practice and promotion of product stewardship

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Clearly, the dominant driving force was one of market defense, in response to aggressive external pressures; however, even at this early point of development of life cycle approaches, LCA demonstrated value as a tool for collection and structuring of product and process environmental attributes.

Most interestingly, stage-two development in Alcan was based on a different set of forces. In essence, the company's initial into LCA demonstrated a value in the tool. It felt that this could be spread to other decision-making activities in the organization. Consequently, over time was developed inside Alcan as a structured framework for environmental management. This has emerged today as a formal environmental Product Stewardship Program that runs parallel to the firm's operations-focused Environmental Management System. To satisfy the needs environmental management system and requirements, as well as external compliance reporting, there is 'stream of information' that is tapped into. This flow information is also used to prepare annual performance reporting on life cycle energy demand (and consequently, climate change impacts) and waste generation (geared at improving internal efficiencies and addressing liabilities).

Package redesign

Packaging for household aluminum foil was redesigned to support the commitment of Alcan Aluminium Limited to government waste-reduction targets for packaging. Through a relatively simple reduction in packaging size, which required some process changes at the manufacturing facility, a 50 percent mass reduction in consumer packaging was achieved.

Environmental aspects of the redesign were quantified using a simplified LCI method. The information was passed on to brand-name distributors of the product, some of whom used the life-cycle data in labels on their final consumer-product packages.

It is important to note that in this instance, improvements in the new version of the packaging were evaluated solely against the previous generation of the same product.

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Activities in LCM

Product stewardship in the Alcan marries economic and environmental concerns, acting as an umbrella for environmental management. The company maintains that the best way of doing business is also the best way to be responsible to the environment. For example, energy reductions and improvements in efficiencies have led to savings of \$10 million annually in the US fabricating division. Building on this success, energy experts have been identified in other divisions.

Product design, process improvement and product recycling improvements are supported by LCA; it is a measurement tool that the company uses to quantify the use of raw materials and energy, as well as the environmental interactions of products throughout their life cycle.

Product stewardship fosters close associations with suppliers and customers, for design and product development and recyclability. LCM of product systems requires inter-industry solutions. In 1991, Alcan cooperated with other aluminum producers in the same sector to undertake a \$250,000 LCA study. LCA work has also been undertaken with GM, Ford and Chrysler and the steel and plastics industries, in a study that took 5 years to complete, and which

provides the most comprehensive application of life cycle analysis to a complex product system (e.g., the family sized automobile).

More recently, Alcan has been instrumental in developing the global aluminum industry database of life cycle information. As a result, recent LCA inventories are being used to supply benchmarking data to the industry on key operating parameters.

Organization and Investment

With the creation of the Environment Committee of the Board of Directors in 1992, Alcan Aluminium Ltd. formalized the incorporation of environmental management into the highest level of decision-making. Corporate environmental policy includes language about achieving “environmental compatibility” of products. The company’s commitment to continual environmental improvement has two foundations: their EMS and their Product Stewardship Program. Both exhibit elements of LCM.

Environmental Management System

Alcan’s EMS is consistent with ISO 14001 but has been tailored to fit integrated approaches at the corporate level, in business units, and for plants. The company uses life cycle information for its major processes to benchmark performance in relation to competitors and to competing materials in specific applications. This helps highlight strengths, identify areas for improvement, and quantifies progress (see “Process improvements” on the following page).

Product Stewardship

Alcan believes that the next great wave of environmental improvements will come through the application of product stewardship. This is addressed in various areas of product-focused environmental management: product design, manufacturing, and R&D.

LCM is the operating concept underlying product stewardship in the company. LCM is explicitly considered as a strategy for *pollution prevention* — to maximize the ongoing reuse and recycling of products and materials, thereby conserving material and energy resources, and to minimize environmental releases related to their production and use.

Value of LCM — Innovation and Competitiveness Innovation — Product Design

The company has completed product “Design for Environment” (DfE) improvements in association with their Product Stewardship Program. Product pollution-prevention is best started with design, where environmental impacts can be most effectively minimized. The environmental benefits of product refinement include increased reuse and recycling, lower use of material and energy resources, and reduced environmental releases related to production and product use. Alcan products, which have been improved through DfE, include beverage packaging, automotive structures, and reusable pallets. Alcan has a strong end-of-life product recovery and recycling program.

Competitiveness — Customer Relations

Product stewardship fosters closer associations with suppliers and customers. The company has actively educated downstream users of their products, reinforcing existing customer relations. Final product development necessitates cooperation of metals suppliers with designers manufacturers. Facilitating recycling manufacturer responsibilities back to the producer. Alcan has developed extensive recycling capacity and actively seeks new and existing sources of recyclable metal.

Life cycle information on environmental performance of specific products is provided directly to major customers. Information the environmental aspects aluminum is available to second-parties on a selective basis, but it is general practice of Alcan publicize life cycle results disseminate data to third parties.

A careful control of life information is exercised. This includes participation in and awareness of associated industry activities and programs undertaken by competitors and downstream users. The supply and dissemination of environmental life cycle information supports Alcan's image and reinforces the value of the company's products in the market.

The use of LCA at Alcan to identify product inefficiencies led to a change in product design and / or manufacture process. These changes improved efficiency and resulted in economic and environmental benefits. Some examples of success in improving efficiency at Alcan include the following:

- **Can Study**

LCM (LCI) work indicated that secondary packaging provided the greatest opportunity for reducing impact. Alcan implemented a take-back policy with its customers of shipping / packaging material used to protect and ship the can stock this included developing a re-usable pallet the secondary packaging accounted for approximately 1/3 of the impact at that time
- **Foil - consumer**

LCM (LCI) work indicated that there was opportunity to reduce impact by reducing packaging. The development / modification of equipment to handle a smaller cardboard core to wind the foil on to significantly reduced packaging demand (by approximately one half). This change had no impact on product quality.
- **Foil - industrial**

Alcan modified the packaging to eliminate the serrated steel edge. The leading edge of the package was reinforced with glue, and serrated for cutting the foil.
- **Shipping Practices**

Alcan developed a re-usable cardboard container that can make 12-15 trips to replace the traditional cardboard container that was only used for one trip.
- **In-Plant Practices**

The company replaced its disposable cardboard bins, on plant sites, with newly developed re-usable, collapsible bins.
- **Automobiles**

LCI / LCA used to verify the benefits of increased use of aluminium (in conjunction with the auto manufacturers). One of these benefits is the lowering of fuel consumption through the construction of lighter weight vehicles, using aluminium parts.

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Responsible use of LCM

Alcan recognizes weaknesses in current LCM tools — LCA for example. The firm sees potential for significant value through the broader application of LCM; however, the company is reluctant to proceed without standardized protocols and approaches. General experience has shown that life cycle tools are potentially dangerous when used externally — it is too tempting to build a biased case when one is a proponent in the marketplace.

Consequently, Alcan has consciously exercised a careful, principled strategy in its application of LCM tools. To support future benefits and applications, company representatives have participated in development of standards and technical methods — at ISO, in technical advisory groups, and other fora in North America and Europe.

Government Influences

The company has used LCM information in its communications with governments. Policy-making can be better supported with broad-based information covering multiple environmental issues — information of the type that is provided by life cycle studies.

Alcan has responded to government initiatives, including voluntary challenges, with projects and programs that draw upon its LCM system and utilize life cycle tools (for an example, see “Package redesign” in section 3 above).

Future LCM Activities

The future of LCM in Alcan appears strong and growing, particularly as after-market demand and product stewardship are acknowledged as key to business sustainability.

One area that is targeted for development is connection of economic costs to the LCM framework. Specific resources have been dedicated to determining the costs and benefits of LCM as part of a broader examination of environment, health and safety (EHS) initiatives. This extends beyond current cost accounting for environmental projects, and includes consideration of life cycle aspects the EHS initiatives. Economic life approaches are desirable for decision-making but require considerable methodological refinement - and alignment to environmental management - before they be widely supported.

Over the longer term, the firm intends to integrate product stewardship and environmental management consistently into day-to-day business operations and practices. This would be analogous to the trend towards integration of product quality as a management objective threaded into all regular activities, from design to production to marketing.

Process improvements	
<p>The LCM program at Alcan is associated with process changes for improving environmental performance. These typically include programs for by-product recycling and reuse.</p>	can
<p>In one case, an industrial furnace was redesigned to use an alternative fuel mix. Nitrogen oxide and particulate emissions were dramatically reduced, while productivity was improved by 33 %.</p>	more

As it may be appropriate, the company is prepared to capitalize on the environmental strengths of its products. The practice and promotion of product stewardship are expected to reveal unique product attributes that promote long-term sustainability. LCM has already helped provide a confidence in the environmental value of Alcan’s products.

For decision-makers, whether in business or for government policy, there are means required to support sustainable development — environment cannot be promoted alone as a one-dimensional issue. Rather, the broader context of sustainability demands multi-dimensional approaches, which present environmental issues along with the socio-economic. For Alcan, the future of LCM is in understanding those important dimensions and, from that knowledge, making decisions in support of sustainability.
