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A Cost Evaluation Framework for Determining Environmental Protection Resource Allocation in a Manufacturing Firm

By
Jeffery S. Everett

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A COST EVALUATION FRAMEWORK FOR DETERMINING ENVIRONMENTAL PROTECTION RESOURCE ALLOCATION IN A MANUFACTURING FIRM

By

JEFFERY S. EVERETT

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfilment of the requirements of the degree of Master of Natural Resources Management.

Abstract

There is strong evidence to support the assertion that current global business practices are not ecologically sustainable. Now, more than ever, industry is being urged to reconsider how it conducts itself. This is due to: (1) growing public concern with environmental issues, (2) the growth of green consumerism, (3) the diffusion of ecological values into political parties, and (4) the intensification of regulation of environmental matters. Why business carries on in an unsustainable manner is largely due to the fact that the expense of environmental degradation is for the most part absent from the prices set in the marketplace. This research is a direct response to the need for more rational and socially-responsible pricing practices.

This practicum describes a number of current methods of cost quantification used in industry, including activity-based costing and quality costing. It then evaluates these methods in light of their applicability in determining resource allocation for environmental protection, and whether these methods are in harmony with industry standards and environmental management and quality systems.

It then reviews the internal cost management practices and environmental management strategies of a case study firm, Northern Telecom, in order to develop a framework that will assist the firm's decision-makers in identifying and accounting for environmental costs. The framework is applied to determine the differential costs involved in the firm's decision to develop and implement an operating procedure.

The framework helped to identify a number of hidden costs and vectors through which costs are imposed by the operation. Many environmental costs will have to be estimated, as the framework does not generate definitive numbers. In order for the information to be useful it must be used strategically. Recommendations specific to the framework and for future research are included, and a guide for the practical use of the framework is appended.

Acknowledgements

I would like to extend my gratitude to a number of individuals. First, to my committee members for taking time out of their all-too-busy days to read and comment on my practicum. Second, to Judy Zieske, faculty administrator, for her genuine concern for the needs of students such as myself. Third, to the people at Apple, Microsoft, and Hewlett-Packard for designing dependable, labour-saving products. And lastly, to the trees that were cut, stripped, pulped and bleached in order to provide the paper for this practicum.

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Chapter 1 - Introduction

1.0 Background

Society's tolerance for industrially-induced environmental degradation has never been lower than at the present time. Many companies are aware of this and are undertaking in varying degrees environmental initiatives to improve their environmental performance. Even so, companies grapple with the justification of allocating resources to environmental protection (EP). This is because there is currently no accepted method of comparing the costs of EP to the benefits accruing from it. Neither is there an accepted method for accounting for these costs on a day-to-day basis.

Up until recently there was no accepted method for a manufacturing firm to compare its costs of quality to the benefits it derived either. However, methods are now available for determining the 'cost of quality' and 'return on quality.' Methods have been developed recently that also allow a company to account for activity costs, and for a company to determine where costs are added during the life-cycle of a company's product.

At first glance, the quality cost method would appear to hold the most promise for use in analyzing EP costs. Many 'quality' companies now measure their costs of quality, and the International Organization for Standards is considering merging its 9000-series quality standard with its soon-to-be-released 14000-series environmental management system (EMS) standard. EP is discussed in trade journals dealing with quality, (for e.g., see Total Quality Environmental Management). Yet, activity and life-cycle costing are also useful for analyzing EP costs, thus making them competitors to quality costing.

Whichever method a company comes to rely upon, one thing is certain: no matter how far advanced management accounting techniques become, they will all fall short of ideal if they continue to measure value and cost on a strictly monetary basis. This point is of utmost importance in regards to EP, which attempts to mitigate the effects of human mercantile activity on a 5 billion year-old life support system. Once it is realized that the most important planetary systems revolve around the movement of energy—not money—then progress toward an optimal system can be made. This research attempted to make such progress.

1.1 Statement of Purpose

The purpose of this study was to describe the current methods of cost quantification used in industry and either select among or integrate these methods so as to help one firm both assess and account for its EP expenditures.

1.2 Objectives

In carrying out this study, certain objectives were first laid out. In the order that they were pursued, these objectives were:

- to evaluate the current methods of cost quantification used in industry,
- to determine which method, or what combination of methods, best enables the client firm to evaluate its on-going and one-time EP costs,
- to develop for future use by the client firm an EP cost evaluation framework based upon the current knowledge of environmental issues as they apply to business and the specific needs of the client firm (this framework is hereafter referred to as the 'EPC framework'), and
- to apply the EPC framework to an applicable problem in the client firm, so as to test the EPC framework's usefulness.

1.3 Methods

1.3.1 Qualitative Research

This study falls under the broad category of qualitative research, as opposed to quantitative research, which typically relies upon statistical analysis and the interpretation of empirical data in order to form conclusions. This study sought to solve a problem; it did not seek to test or validate a hypothesis.

There are a number of researchers who believe that qualitative research is particularly well-suited for certain areas of inquiry (See Denzin 1970 and Patton 1980). One of these areas is when a situation is previously unstudied or a solution to a problem is sought. Heelan (1983) adopted a qualitative approach in her analysis of quality circles for this reason. Three other qualitative research characteristics (Eisner 1991) apply to this study: "qualitative

studies tend to be field-focused; in qualitative studies the researcher acts as instrument; and qualitative studies become believable because of their...instrumental utility."

There was a need to 'ground', or operationalize, the EPC framework by conducting an inductive study, so that the findings of the study were not implausible. This was done by eliciting the help of the client firm in developing the model. It helped to avoid reliance upon the idea that the researcher is the primary source of "knowledge, good sense, and sound logic", a problem identified by Bruyn (1966: 12). Detailed analyses of the heuristics involved in subjective assessments are provided by Cooper and Chapman (1987: 93) and Mock and Vertinsky (1985: 23) and these were reviewed in order to avoid some of the problems of qualitative research from occurring during this study. Primary among these problems is the researcher's failure to be objective and minimize biases.

1.3.2 Sample Source

The development and evaluation of the framework was carried out at a manufacturing facility belonging to Northern Telecom Limited (See Appendix 1 for background information). It was chosen for a number of reasons. First, there was and is a high degree of interest and cooperation among management to deal with environmental issues. Second, at the time the research began the facility was having difficulty assessing a number of expenditures related to EP (namely, a commitment to the full implementation of an environmental management system). Third, the researcher worked at the plant for twelve weeks (developing the environmental management system) prior to conducting the research and so was familiar with the operation.

It is worthwhile to discuss the environmental efficacy of this operation as it is, in terms of environmental performance, somewhat typical. The operation is indicative in this sense of many other large, multi-national businesses, which have the resources to maintain relatively high performance standards. The result of choosing such an operation is that this study provides conclusions which have greater applicability. This relates to what Yin (1989: 40) terms external validity.

The environmental effects of this operation may be classified as relatively benign. This is because there are industries which have a far greater effect on the environment: chemical manufacturing, pulp and paper, forestry, and oil and gas to name a few. This is not to say there

are no environmental effects; in fact it was only up until a few years ago that this firm's elimination of chlorinated fluorocarbons (CFCs) drew much media attention.

The primary effects that the operation of the firm has on the environment are mostly atmospheric in nature: lead pollution from soldering activities, the release of volatile organic compounds (VOCs), and to a lesser extent ozone depletion from the use of HCFC cleaners on circuit boards. Again, these effects are of a small magnitude, relatively speaking. Secondary effects stem from the demand for coal-generated electrical energy, water, and office supplies. Waste production and a certain amount of potential damage which may occur from the improper handling of hazardous goods such as acetone, battery acid, and lead dross are also to be considered. An additional list of concerns includes effects which stem from the activities of suppliers, such as solder and chemical manufacturers, and contractors, such as cafeteria, custodial, and landscaping suppliers. The total of these effects are substantive in amount and magnitude, which is one reason why there is a large number of relevant environmental regulations governing the facility (Appendix 2).

1.3.3 The EPC Framework

1.3.3.1 Preparation

The research process began with a general review of the current and appropriate methods of cost accounting and cost determination. This review was supplemented with a review of the environmental issues, laws, and standards facing business today. The purpose of taking such a wide approach was to ensure that the research question was addressed in an interdisciplinary and holistic manner.

1.3.3.2 Review of Environmental Management Strategies

The research next involved a review of the client firm's environmental management strategies. This involved an examination of corporate-level documents, reports, and presentation materials as well as discussions with corporate-level and operation-level environmental specialists. The purpose of this review was to gain an understanding of the context in which the research was carried out and determine the general needs of the client firm.

1.3.3.3 Method-Feasibility Assessment

So that the EPC framework was specifically tailored to the needs of the client firm, the current methods of accounting used by the operation and any other relevant needs had to be assessed. It was decided that representatives from those functional areas using the framework would have to be contacted and their input documented. This was done by contacting the respective heads or senior members of the quality, accounting, resource protection, and engineering departments; who then either offered their own or a suitable subordinate's time for an interview. These individuals were then provided with an outline of the research with salient background information (Appendix 3), which they were given time to read. The researcher then sat down with these individuals for an average of one hour and carried out the interviews, which were recorded on paper. If clarification was needed regarding any of the comments, the individuals were subsequently contacted by telephone.

1.3.3.4 Formulation

After these assessments occurred, a hypothetical EPC framework was developed. This was done by combining the information which appears in the literature review with that obtained from the firm's representatives. The result was a framework designed to model the decision-making process and the environmentally-related costs incurred and imposed on society by the firm. The framework was designed to give visual clues and stimulate thinking about EP costs. This framework was further supplemented with two smaller decision-making models, which are referred to as the Contingency Decision Tree and Risk Factor Evaluation models.

1.3.3.5 Evaluation

The EPC framework was then applied to a real-world situation in the client firm. This consisted of an analysis of the differential costs of developing and implementing a single procedure needed to partly fulfill the International Organization for Standards' (ISO's) soon-to-be-released environmental management system (EMS) standard requirements. Chapter 4 demonstrates the use of the framework in this situation. This gives interested parties the chance to see how the framework operates, how it is beneficial, and to see its limitations.

1.4 Statement of Need

The client firm is currently unable to adequately measure and control its EP costs and satisfactorily allocate the firm's resources. Nor is the client firm currently able to consistently and quantitatively demonstrate the financial importance of environmental protection and identify areas where environmental improvements should be made. If the EPC framework does what is intended, it will "strengthen the linkage between the corporate accounting system and the environmental management system," a general need of business identified by Willits and Giuntini (1994). Lastly, the client firm has identified a need to conduct an assessment of the risks it poses to the health and safety of its workers and the public, and risks to the environment.

This firm's need for an EPC framework is not unique, as most firms do not have an EPC framework available to them. This is not surprising given the infancy of environmental protection initiatives and the fact that "the literature on management of environmental issues provides very little guidance on how to forge a link between the normative and the practical" (Corbett and VanWassenhove 1993). Therefore this research is needed not only by the client firm, but other firms as well.

1.5 Assumptions

An assumption that warrants attention is that corporate environmental protection is desirable by industry. This assumption seems legitimate in view of a number of features which characterize the present era of environmentalism. These include growing public concern with environmental issues, the growth of green consumerism, the diffusion of ecological values, and the intensification of regulation of environmental matters (McGrew 1993). If it were the case that EP was not considered important, then this research would not be needed.

1.6 Definition of Terms

Some terms that are used frequently in this research require qualification.

Environment

The term *environment* will be taken hereinafter to mean the components of the Earth, and includes

(a) land, water, and air, including all layers of the atmosphere,

(b) all organic and inorganic matter and living organisms, and

(c) the interacting natural systems that include components referred to in (a) and (b).

(§ 2(1) CEAA c.37 1992)

Protection

The term environmental *protection,* (EP) is also often used. Its use is not intended to imply that an entity necessarily protects the environment, as few if any firms contribute a benefit to the environment. Accordingly, environmental *protection* means the purposive minimization or mitigation of the firm's effect on the natural environment.

Cost

The following cost definitions, provided by Hansen *et al.* (1995), are used in this practicum:

Cost is the cash or cash equivalent value sacrificed for goods and services that are expected to bring a current or future benefit to the organization.

An *internal cost* is any cost that is both incurred and borne by an organization.

An *external cost* is any cost that is incurred or caused by an organization but which is borne by society.

Management

Drucker (1974: 399) provides an eloquent definition, wherein *management* contributes to "the *creation* of a productive entity that turns out more than the sum of the resources put into it, and the *harmonization* in every decision and action of the requirements of the immediate and long-range future.

Quality

Quality is the "totality of features and characteristics of a product or service that bear on its ability to satisfy given needs" (ANSI/ASQC 1978), or "the essential character of something" (Morse 1993). It is not meant to convey the same meaning as the adjective *good.*

1.7 Organization of the Practicum

This practicum is composed of six parts, five of which are separate chapters. The first chapter lays out the background, objectives, the methods of achieving those objectives, and some limitations and terminology.

Chapter two is a review of the relevant literature pertaining to this study. It is in chapter two that the costs and benefits of EP are identified, the systems approach to EP discussed, a number of standards guiding industry elaborated upon, and the methods of cost accounting and determination briefly examined.

Chapter three concerns the information obtained from the client firm on its environmental management strategies, its current manner of accounting for EP costs, how that firm incorporates EP into its financial decisions, and on some of its future needs with regards to EP costing.

Chapter four introduces a framework which will allow the client firm to analyze its EP costs; applies the framework in a practical situation for demonstrative purposes; and discusses the results and limitations of the application.

Chapter five summarizes and concludes the research and offers recommendations for the client firm and for future research. A sixth section, the appendix, contains a number of items referred to in the body of the practicum.

Chapter 2 - Review of Related Literature

2.0 Introduction

A manufacturing firm must address environmental matters if it is to survive in today's increasingly legislated, publicly accountable, and highly competitive global marketplace. This is not to say that any less attention should be paid to a firm's cost and other concerns in doing business, as attention can be paid to all of these areas simultaneously. However, for a firm to do this, an understanding is needed of the reasons why it should: (a) enhance its efforts at environmental protection, (b) use the systems approach to environmental management, (c) concern itself with both the explicit and implicit standards which are placed upon it, and how it should (d) extend its measurement of costs to include non-monetized costs, i.e., the costs of environmental resources. These areas will be discussed in turn in this chapter.

2.1 Emergence of Need to Address Environmental Issues

A major reason for a company to undertake environmental initiatives is economic, being that the wealth of stockholders is management's top priority (Drucker 1984). Of concern, then, are the costs and benefits associated with environmental protection—for these can be quite substantial. However, there also appear to be ethical reasons driving these initiatives, as many of the pronouncements (see for e.g., IISD 1992 and UNEP 1991) regarding sustainable development, if taken at face value, would show.

2.1.1 Cost Motivations

Environment-related expenditures are of concern to managers, as job performance evaluation is tied to cost reduction and profitability in most firms. If they are not of concern, perhaps they should be, given their potential size. Noranda Minerals Inc. reported that it spent $34 million on environmental initiatives in 1990 (Annual Report 1990). Ontario Hydro's expenditures on environmental programs reached $375 million by 1990 (Annual Report 1990). In a sample of 46 of the largest companies in Canada, Saxe (1993: 47) determined that one half spend one to five percent of their annual revenues on environmental matters. In the United States, the Environmental Protection Agency estimated that compliance with its rules cost business $140 billion in 1992, three times what it cost ten years ago. Further, the proportion of

U.S. GNP devoted to environmental protection is projected to grow from 1.7 percent in 1990 to nearly 3 percent by 2000 (Hemphill 1992).

The costs of environmental management are both of a one-time and on-going nature. The once-off, or capital costs, are the initial investments to control, neutralize, recycle, dispose or otherwise treat the output of processes (Rothery 1993: 72). An example of these costs are the costs associated with developing and implementing, but not monitoring, an EP program. These capital costs also have a greater impact on smaller and marginal, or less profitable, firms (Dudek et al. 1990: 38). The on-going or day-to-day costs include the maintenance of the environmental component of the company's assets, staff salaries (for e.g.., for monitoring EP programs), consulting fees, staff training, audits, and inspections.

Up until now the discussion of environmental management costs related to those costs incurred by a firm taking action to improve or maintain environmental performance. There are significant costs incurred by the firm of not attending to environmental matters. For instance, the inefficient use of energy, water, or other production inputs and excess waste disposal costs may be appreciable (Morse 1993). Humankind is nowhere close to the completely efficient utilization of resources (i.e., 'waste' will probably always be produced). There are the opportunity costs associated with product boycotts due to a poor environmental image. Lastly, due to customer requirements, there is an additional and potentially significant cost of being locked out of a trading situation by potential suppliers and customers. An example of this is British Telecom's requirement that suppliers give assurances concerning their performance on a wide range of environmental issues, or they will be excluded from the trading list (Corbett and Van Wassenhove 1993). With British Telecom buying 250,000 products from 20,000-30,000 regular suppliers, this point does not go unnoticed. There are also costs in not being able to attain or maintain environmental, industry standards. Rothery (1993) asserts that failure to conform to an accepted international environmental management system standard—namely ISO 14000, which may come into effect as early as 1997—will one day lock firms out of desirable trading situations.

All of the costs mentioned above can be classified as either capital or operating costs. MacKnight (1994: 5-3) identifies another capital cost which is the cost incurred as a result of a breach of an environmental law. The U.S. General Accounting Organization stated in a recent report surveying nine insurers involved in 2,393 environmental lawsuits that the average firm spent $16 million on each suit (Willits and Giuntini 1994: 45). The delays involved in these suits, the stress placed upon management and shareholders, and the uncertainty of the outcome could raise this figure even more (Swanson and Hughes 1990).

2.1.2 Benefit Motivations

If Cairncross (1992: 177) is correct in saying that most companies have been driven more by the anxiety about the costs of getting an environmental decision wrong than the opportunities from getting it right, then it would seem fair to say that the benefits from environmental management have not been given their due. Yet these benefits, it appears, are many. The 3M Company may be the most quoted example of an American company reaping rewards from enhanced environmental protection; as of 1986 the company's Pollution Prevention Pays (3Ps) policy has netted the company over $500 million (Shimell 1991:15). Bell Canada has realized savings of almost $80,000 annually on janitorial labour, supplies and disposal costs, all for a $50,000 investment (Globe and Mail 1992). The retail company Woodwards saved $400,000 through its energy conservation program (Banks 1992). Xerox claims to have reclaimed metals from photoreceptors with annual yields of 800,000 lbs. of nickel, 600,000 lbs. of aluminum and 160,000 lbs. of selenium (Xerox 1991). Kodak claims it has decreased chemicals required for producing colour prints by 90% over the last 20 years (Kodak 1991). DuPont is selling $1 billion worth of safety expertise to industrial customers (Corbett and Van Wassenhove 1993: 120). A study by INFORM, an American, non-profit environmental research and education organization, found that most companies' cost savings can be determined relatively easily (Underwood and Dorfman 1990: 65).

Saxe (1993) offers a comprehensive list of advantages and benefits from environmental protection: (a) reduced frequency and severity of environmental problems, (b) improved efficiency, reduced waste and cost savings, (c) improved access to equity and debt capital (by satisfying increasingly stricter lending requirements), (d) improved access to environmental impairment insurance, (e) better public and employee relations, (f) better compliance with financial disclosure requirements which increasingly require disclosure of environmental risks and liabilities, and (g) greater flexibility and resilience in coping with the increasing flood of regulation. Rothery (1993) adds two additional indirect benefits: enhanced corporate image and marketing capabilities. Similar benefits have been identified by at least two other commentators (Todd 1994; Cameron 1993).

There are three less apparent benefits from environmental investment which accrue to a firm. The first are the capital cost allowance adjustments which may be made in respect of pollution control equipment, although this is currently only the case in the provinces of Ontario and Quebec (MacKnight 1994: 5-43). The second benefit is derived from the tax deductible nature of costs incurred to ensure that the particular business is run in compliance with existing

regulatory requirements (Ranson 1993). Although both of these items appear as non-cash items on the company books, i.e. there are no cash outlays *per se*, they are nevertheless financially significant. Lastly, an environmental leader will be able to influence industry and regulatory standards to his or her benefit by engaging in what is known as 'rent-seeking' (Booz-Allen and Hamilton, 1991; Thornton, 1983).

2.1.3 Value Motivations

There are, it can be assumed, ethical or value-driven reasons for pursuing environmental improvements in day-to-day operations. These are likely subtle, although judging by the number of sources (DeLoitte Touche Tohmatsu 1993, IISD 1992, UNEP 1991) in which there are descriptions of companies adopting environmental programs for not merely pragmatic reasons, but rather for reasons of contributing to the welfare of future generations, one would think that altruism is a significant motivator in corporate board rooms. It is not the purpose of this paper to explore the degree of altruism which exists among corporate managers, but at least some philanthropic tendencies exist given the jingoism surrounding the term 'sustainable development' (See WCED 1987) and industry's participation at the UN conference held in Rio de Janeiro in June 1992.

2.2 Emergence of Systems Approach

Many businesses now operate within an environment that is global, complex, and systematic (Mitroff 1994). This inter-relatedness probably stems from increased technology and demographic pressures, and certainly exists at the economic, industry, and firm levels. The recognition of the systemic nature of firm policy and decision-making has led to new and important business science studies, pioneered by J.W. Forrester (1961) and made current by Simon (1979), Perrow (1984), and Senge (1990), among others.

This systemic approach is evident with regard to environmental initiatives also. Where firm initiatives began as simple, single-issue responses to problems, such as the elimination of CFC use, in some cases they have moved to systematic, multi-issue responses, such as the implementation of a corporate-wide environmental protection program (e.g., Northern Telecom). This is not to say that all firms have comprehensive environmental programs—

though this is generally the case in large companies (Rappaport 1992)—or that all firms are adopting these programs (Mahon 1982).

It makes sense, then, that many of the latest management approaches are concerned with systemic relationships. The most visible example of this in the general business case is Total Quality Management (TQM), and in the environmental case, the environmental management system (EMS).

2.2.1 Total Quality Management

The concept of quality as it relates to a firm's entire procurement, production, and distribution process emerged in the 1980s (See Deming 1986; Ishikawa and Lu 1985). The approach has became known as Total Quality Management (TQM), a key objective of which is the assessment of the sources of defects in the general manufacturing and management systems of an organization (Mitroff 1994). TQM is a systematic and cross-functional strategy approach.

With the adoption of TQM, new research has emerged. Most notable are the findings that indicate that quality supersedes price in the decision-to-purchase (Harrington 1987; Martin 1987). It appears that the attention to quality may be more than a fad.

As was mentioned earlier, the term *quality* means "the essential character of something." This definition has utility because of its value-neutrality. This is particularly important with respect to the environment, where there is a tendency for discussions to become emotion-charged. Using *quality* in this sense means only that the firm should be judged on its ability to comply with the demands of its customers. The point is raised because it is logical today for a firm to include environmental considerations in its quality initiatives. Cairncross (1992: 281) recognizes this:

> "Some managers wonder whether traditional definitions of quality that apply to customer satisfaction should be broadened to incorporate environmental criteria and extended to all who are affected by a product from its cradle to its grave."

Tuppen (1994) says that: "customers like to do business with a quality company and increasingly, environmental concerns are seen as an essential component of quality". The environmental consultants at Ernst and Young (1994) are of a similar opinion: "one of the items in an overall environmental business strategy is the quality strategy, which should be designed to eliminate or minimize outputs that have a negative impact on the environment." Not

surprising, then, is the emergence of Total Quality Environmental Management (TQEM), the subject of one journal and numerous global-level business discussions (see for e.g.., those of the Global Environmental Management Initiative—GEMI).

2.2.2 Environmental Management Systems

From this systems approach and the lessons learned from TQM there has evolved the *environmental management system* (EMS).[1] Environmental management system is the term used to describe the company structure, responsibilities, practices, procedures, processes and resources put in place to implement the environmental policy and its associated objectives and targets (Ernst and Young 1994). An EMS emphasizes prevention of adverse environmental effects rather than detection and amelioration after occurrence (Willits and Giuntini 1994). Rothery (1993) agrees with these definitions and adds that for an EMS to be legitimate, accreditation under a meaningful standard must be attained. What exactly is a meaningful standard? There are in fact many different standards that are both implicit and explicit.

2.3 Emergence of Standards

2.3.1 The ISO Standards

Less than a decade ago, the International Organization for Standards (ISO), a consortium of standards bodies from virtually all the world's industrialized nations, implemented the ISO 9000-series, quality system standards (these are also known in Canada as CSAZ 299). Soon ISO will release the ISO 14000-series standards, which will address environmental management systems. ISO's latter standard is based upon British Standard 7750 (BS7750), and in its draft version contains few amendments to BS7750. For this reason, the EMS standard BS7750 can be considered *the* EMS standard (see Appendix 4). The implicit purpose behind all of these standards is to reduce, if not eliminate, the number of spurious claims regarding 'quality' and 'environmental competency'.

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[1] So involved is this concept of the 'system' in the management arena, that manufacturing facilities and even industry itself are being viewed by some as analogous to imperfect (i.e., open) biological systems. (See Allenby and Richards 1994) This is an important concept as the awareness that human activity is inextricably linked to the natural environment continues to grow.

The ISO standards may be integrated in the future so that an accredited company will have a better way of demonstrating legal compliance with environment, health, safety and quality demands (Rothery 1993), all in one go. It is here in the context of the ISO standards that one sees a strong connection between quality and environment, and this should suggest that the concurrent implementation of both standards should be examined by a firm.

2.3.2 Explicit and Implicit Standards and Environmental Law

Standards can be either implicit or explicit in nature. An explicit standard is defined by Dale and Oakland (1991: 19) as:

> "a technical or management specification or other document. It is a precise and authoritative statement of the criteria necessary to ensure that a material, product or procedure is fit for the purpose for which it is intended."

A look through ISO 9000 series standards, shows that a standard can be clear in its requirements. Similarly, a look through the British Standards Institute's environmental management system standard BS7750 shows that an EMS standard can also be quite clear.

For a business, there are advantages and disadvantages to adhering to standards. On the downside of moving to standardization, a company may experience a marginal increase in costs, it may experience many practical obstacles in implementation and enforcement, it will have to endure the costs of the standardization exercise and maintenance, and it will find its freedom of choice restricted (Dale and Oakland 1991).

On the upside of moving to standardization a company may experience: reduced overhead, labour, equipment, and material costs, stock investment and stores space; improved availability of parts, management control, quality, and reliability; and increased customer satisfaction, manufacturing efficiency, communications, and compliance with legislation (Dale and Oakland 1991).

These benefits are usually "proportional to the number of activities that are affected by a standard or a group of standards" (Lamprecht 1993). Besides shedding light on why some companies are motivated to adhere to standards, this delineation of the advantages and disadvantages of adherence to standards may help to explain why North American businesses are not as familiar or as interested in complying with standards as their European counterparts. As Johnson (1993) observes, the European business milieu is heavily influenced by standards.

Environmental protection programs are subject to both explicit and implicit standards. This is unfortunate for business managers as implicit standards are difficult to define, and thus adhere to. They exist in numerous quarters, are dynamic, and are open to wide interpretation. So a careful look to find these standards is required by the decision-maker. One area of major importance in which to look is the legislation, case law, and the customs which prevail in the society. These are the standards that mesh with a combination of right reason and the traditions, customs, and character of the community (Harvey 1994), and so are accepted. Perhaps an effective way of understanding the implicit standards is to focus on the likelihood of having to use the environmental due diligence defense, and the sentencing which may result from the failure to establish it.

2.3.2.1 Due Diligence

People working in certain industrial occupations are required to keep abreast of environmental law developments, one of the most significant of which is environmental due diligence. Due diligence is defined as: taking all reasonable precautions in the circumstances for the protection of the environment (Saxe 1993b). If it can be shown that all reasonable care was taken to prevent an offense, or that the accused believed in a mistaken set of facts which, if true, would render the act or omission which constitutes an offense under the act, innocent, the accused may escape conviction (Rutherford 1992). It appears that if a firm practices due diligence it will be conforming to a set of implicit standards which govern the firm's EMS.

The elements required to establish the due diligence defense in Canada are fairly well documented (See Donahue 1994; Cameron 1993; Currie 1993; Dykeman 1993; Saxe 1993a). A look at these elements reveals that if a firm were to incorporate them into its corporate environmental policy, see that this policy was incorporated into the firm's environmental management system, and then ensure that the system was working, it would likely have achieved a 'reasonable' level of care.

Though adhering to an EMS standard moves a company beyond mere legislative compliance, if a firm does not wish to commit or have the resources to fully establish, implement, and monitor an EMS, it could be subject to fines, penalties, and other contingent liability costs. It would therefore be desirable to estimate the magnitude of these costs, and to do this an analysis of the compliance status for each piece of legislation as it applies to the

firm must be carried out.[2] In addition, an analysis of the types and severity of sentencing, and the prevailing enforcement attitude in the jurisdiction must also be carried out.

It should be pointed out that this work emphasizes a Canadian analysis, as the American jurisdiction is different. In regard to the environmental regulatory approach, the Canadian approach has been described as employing a relatively closed, concensual and consultative approach; the American approach follows a more litigious and adversarial pattern (Huestis 1993).

2.3.2.2 Sentencing

In recent years the range of sentencing options for environmental violations has gradually expanded. A small portion now includes imprisonment, regulatory orders, restitution orders, forfeiture of property, stop orders, ticketing, absolute and conditional discharges, suspended sentences, probation, and performance guarantees (Swanson 1990). The size and nature of the penalty which may be conferred upon the business in the event of a conviction is diverse.

Despite this diversity, the prior quantification of a penalty may be possible using historical data. In individual cases, for instance, the average fine imposed based on 381 cases in Ontario in 1989 and 1990 was $11,383 (Huestis 1993). Data on firms being penalized to the degree to which they benefited by non-compliance, the so-called Connecticut Enforcement Plan (a U.S. term) (Mitnick 1980), is also available.

Of course the legislation also provides figures for quantification. There one finds that fines on companies for emissions of a contaminant in contravention of the law range from $2000 to $250,000 for a first offense depending upon the jurisdiction. Fines for subsequent offenses range up to $1,000,000, and each day of occurrence is considered a separate offense (CICA 1992). These penalties also extend to individuals such as directors and officers (See *R. v. Bata Industries*[3]).

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[2] A general analysis was not discused here because of the diversity of legislation in the varying jurisdictions and the limited scope of the paper. However, an analysis of the compliance status of the client firm was carried out in August 1994.

[3] Regina vs. Bata Industries Ltd., (1992) 70 C.C.C. [3rd] 394.

A corporate decision-maker can obtain a rough idea of the severity of the sentence handed down by the courts if a situational analysis of his or her firm is conducted. Swanson (1990) identified three broad criteria which may be used: damage, intention, and profit realized. This is not to say that intent is required, as *R. v. Sault Ste. Marie*[4] has shown, only that intent aggravates the sentence.

Swaigen and Bunt (1985: 5) provide an even more comprehensive list of factors which determine the sentence: (a) extent of the actual and potential damage, (b) intent, (c) savings or gain derived from the offense, (d) severity of intent, (e) ability to pay, (f) size and wealth of the corporation, (g) anthropomorphic factors (corporate character, contrition or remorse), (h) guilty plea, (i) cooperation or expenditures, (j) laxity of government agencies, (k) reasonableness of standards, (l) prior convictions, (m) tax consequences of the fine, (n) dismissal of employees responsible for the offense, (o) ease or difficulty of preventing pollution, and (p) social utility of the enterprise.

In purely theoretical terms the optimal penalty can be determined by the decision-maker: the expected penalty is equal to the expected cost of action to mitigate or avoid environmental damage. Arlen (1993: 3) elaborates on this principle and has devised an elaborate equation which represents it.

2.3.2.3 Trends in Enforcement

Laws are only as good as the enforcement behind them. Therefore, it is worthwhile to examine the trends in environmental legislation and common law together with the enforcement situation in Canada, so as to aid the decision-maker in his or her estimation of the costs which the firm may be facing.

The number of industries subject to the scrutiny of environmental regulators and society in general has increased dramatically in the past thirty years: from 5 major industries in the 1960s to 54 in the 1990s (Elkington 1994). The trend in laws governing criminal liability for corporations is toward increased liability (Arlen 1993), although what effect liability has had on the traditional sources of air and water pollution is questionable (Reuter 1988). It appears also that convictions are justified as virtually all of the cases prosecuted to date

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[4] Regina vs. Ciy of Sault Ste. Marie, (1978) 40 C.C.C. [2d] 353.

involve the most flagrant of circumstances where accountability would be expected (Bowal and Ingelson 1993). Saxe's (1993a) observations have led her to the conclusion that the standard for due diligence in Canada has been rising steadily for the past five years. The support for more regulation is also on the increase (Huestis 1993).

The results can be dramatic if enforcement is actively pursued. Following 1988 in Alberta, the Pollution Control division of the environmental department was reorganized to give more emphasis to the enforcement function in response to the recommendations of a provincial task force. Fifteen control orders, one stop order, and four tickets were issued in the first six months of 1989, compared to the previous annual average of less than six Ministerial orders and no tickets, established during the period of 1980-88 (Huestis 1993). These numbers are increasing nationwide (Donahue 1994).

In many jurisdictions, the penalties for environmental offenses have not only increased in number but also in magnitude (Huestis 1993; Dewees 1992). In the United States this also appears to be the case. In the 1988-89 fiscal year, the EPA imposed some $37 million in fines for environmental crimes. That was a quarter of the entire amount levied by the agency since 1974 (Cairncross 1992).

Tort law will continue to play only a small part in environmental cases. This is a result of the inherent problems regarding the proof of causation and the limited nature of the standing to sue. The common law causes of action (e.g. nuisance, strict liability) will be used more frequently if these problems can be mitigated (Dewees 1992).

2.4 Accounting for Cost

Looking at the explicit and implicit standards which govern a company's EMS provides the decision-maker with an idea of the legal and quasi-legal environmental issues which must be considered. However, the corporate decision-maker needs quantifiable data in order to make decisions. This, it seems, should be provided by the company's accountant or financial analyst, whose role is to provide financial information. The following section begins by briefly reviewing some of the traditional and newer ways that these individuals handle such information, and then moves to a discussion of some of the less traditional costs which are now being analyzed.

2.4.1 The Accounting System

An organization's financial information may appear in either of two forms, depending upon the purpose for which the information is intended. If the information is to be used internally, the financial information is prepared according to the conventions of managerial, or cost, accounting. If, on the other hand, the information is intended to be used externally, then it is prepared according to the conventions of financial accounting. Some other demarcating features are also of interest. Managerial, or cost, accounting:

1. places more emphasis on the future
2. is not governed by generally accepted accounting principles
3. emphasizes the relevance and the flexibility of the data
4. places less emphasis on precision and more emphasis on non-monetary data
5. emphasizes the segments of an organization, rather than just looking at the organization as a whole
6. draws heavily from other disciplines
7. is not mandatory

(Garrison 1988: 14)

Traditionally, managerial accounting has allocated costs to a unit of production. One of the reasons for this is to simplify categorization and minimize computing time. One of the problems with this method relates to the fact that a substantial amount of the costs incurred by the organization are not easily assigned to a given product. Factory lighting is an example of such a cost which is usually assigned to 'general overhead'. Direct labour has been the traditional basis for the allocation of overhead, as it was until recently the major overhead cost (Stevenson et al. 1993). With the natural progression of the technology of information systems, new methods of allocation and greater possibilities exist for determining production costs. One such method is activity-based costing.

2.4.2 Activity-Based Costing

For several years now, activity-based costing (ABC) has been the pre-eminent topic in management accounting (Drumheller 1993: 21). Activity-based costing, like traditional costing, is designed to inform management about the economics of its past, current, and future operations, but differs in that it allows management to see information on the quality, process time, and cost of their activities (Kaplan 1992). The basic premise of ABC is to cost activities, not products. Costs are allocated to the products on the basis of the individual product's demand for those activities. The allocation bases, or cost drivers, are the quantification of activities performed. Two types of cost drivers exist: those that consume activities and those that consume resources.

One way that ABC currently allocates activities is among four levels: unit, batch, product-sustaining, and facility-sustaining (Kreuze and Newell 1994). The activities performed at these levels can also be separated into two different categories: micro and macro activities. This distinction allows for more meaningful and efficient use of data, as demonstrated by National Semiconductor Corporation in 1991. In their words, "the micro/macro distinction is the most significant development in the design of ABC models in recent years" (Turney and Stratton 1992).

Activity-based management provides an organization with:

- identification of the source of costs by identifying cost drivers
- data to support budgeting by determining the cost/activity relationship of different activities
- flags to non-value-added activities, facilitating the minimization of waste of resources
- bench-marking data to externally set target performance and cost goals
- emphasis on fixing the source of the problem, rather than treating the symptoms

(Source: Northern Telecom 1994)

Activity-based costing offers great potential for capturing and presenting the effects of the overhead that can be attributed to environmental management: permitting costs, compliance costs, technology modification, environmental auditing, the environmental management system, risk management, recycling and reuse (Brooks *et al.* 1993). An important point to raise here, however, is that ABC does not allow one to decide, when environmental

considerations are taken into account, if an investment will provide a positive net present value. For this, a capital budgeting analysis is needed. This subject will be addressed shortly.

2.4.3 Full Cost Accounting

Managerial accounting has a number of objectives to fulfill. It must direct managerial attention to problem areas, provide informational support for managerial decisions, and in decentralized organizations, promote the harmonization of divisional goals with corporate goals through performance measurement and incentive mechanisms (Todd 1994). However, can the present managerial accounting methods do this? No, simply because present cost reporting systems do not take into account all of the transactions which have an effect on the value of the firm. After all,

> "An objective of financial statements is to report on those activities of the enterprise affecting society which can be determined or measured and which are important to the role of the enterprise in its social environment." (Spicer 1978)

Four levels of environmental costs that are important to a full-cost analysis have been identified by Bailey (1991). These are: usual and operating costs, hidden regulatory costs, contingent liability costs, and less tangible costs.

Consider the following example of a company that does not account for the full costs of carrying on its business activities (from Rubenstein 1992). The company has always been a leader in meeting regulatory requirements. However, it has been discharging toxic wastes—well within stipulated limits—for the last decade. Cleanup costs have been estimated at $500 million. Based on the recent implementation of joint and several liability, according to Rubenstein (1992), individual shareholders will be jointly and severally liable for the cleanup. This suggests that on the whole, shareholders' income and dividends have been overstated for the last decade.

Traditional accounting systems have ignored many of these costs because of the inability or unwillingness of the accountant to provide clear, understandable information regarding the transaction (Hawkshaw 1991), and also because of the absence of the transactions in the first place (Elias 1995). However, the need to factor in these costs is critical (Nandakumar 1993; Vredenburg 1993).

Full-cost accounting, full-cost absorption, or, as it is also known, Total Cost Assessment (White 1993) has been heavily criticized in the past for its subjectivity. Cobb (1994) points out that perhaps it was the past system that was subjective. One must question the validity of assigning zero values to fairly significant items. He is not referring just to old growth forests and northern spotted owls (which were essentially assigned zero values in national accounts), but also the many uncosted or unassigned items within the business. For example, consider product-related legal expenses, regulatory costs, public relations expenses and the opportunity costs of clean technologies not adopted (Todd 1994). There are also waste disposal costs which are perhaps double the actual cost to the company when account is made of lost production and operating costs. When future liability for waste is added in, the costs could be doubled again (Cairncross 1992).

Allenby and Richards (1994) suggest that it is not the accountant's aversion to subjectivity or his or her inability to quantify many of these values that is the sole cause of the problem. Much has to do with the fact that most managers are not interested in additional costs to which they will be held accountable. Environmental regulatory authorities and accounting rule-making bodies also enter the picture, as further disincentives to adopting the full-cost approach exist within these groups (Todd 1994).

This begs the question of what are the techniques and practices of full-cost accounting? Unfortunately, there are no generally accepted techniques or practices in place, although work is still ongoing (Myers 1993; CICA 1992; Society of Management Accountants of Canada 1992). Ontario Hydro's work in full-cost accounting is particularly notable (Elias 1995). Bailey (in Kreuze 1994) has also moved us somewhat closer to this end, as he has identified four general levels of environmental costs that are important to a full-costing analysis: hidden regulatory costs; contingent liability costs; and less tangible costs, which he terms usual capital and hidden regulatory costs. These include notification, reporting, permitting, monitoring, testing, training, and inspection procedures. The contingent liability and less tangible cost categories are much more difficult to estimate.

2.4.4 Life-Cycle Costing

Before looking at these other cost categories, another accepted costing technique must be examined. This is life-cycle costing, which "considers the full costs over the product's, system's, or operation's life cycle—from research through disposal, from cradle to grave" (Kreuze and Newell 1994). The implication that life-cycle costing has for analyzing EP costs relates to two

traditionally ignored stages of the product's life, which are the product's rise from the natural resource base and the product's expiration, with its attendant affects on this base. The big issue here, however, is assigning or apportioning responsibility for the product at each of these stages.

2.4.5 Quality Cost Accounting

Another manner of accounting for cost is the approach used by those trying to track the 'costs of quality'. This is known as TQM cost accounting. TQM cost accounting is not an accounting approach *per se*. It is simply a combination of the management, ABC, and perhaps, depending upon the accountant, the full-cost approaches.

In ensuring that the manufacturing or service operation's product conforms to the expectations of the customer, a firm incurs costs (Morse 1993). Likewise, a firm incurs costs in failing to ensure conformance. (Incidentally, this is no different in the case of a firm's assurance or failure to ensure environmental quality: costs are incurred, and so the terms are interchangeable.)

The overriding objective of quality cost control is simply to ensure that management has a systematic means of planning and controlling quality costs (Morse 1993). The financial consequences of quality problems can thus be quantified and areas for quality improvement and cost reduction identified (Rust et al. 1994).

Typically, the only cost attributed to poor quality and identified with individual products is the direct cost of defective units produced during the manufacturing cycle (Nandakumar et al. 1993). Take the example of an environmentally 'defective' product, an uneasily recycled electronic device which, instead of lending itself to quick disassembly, has to be returned to the manufacturer. The direct cost of this 'defect' is the cost of handling and disassembly.

There are, however, indirect and intangible failure costs to be taken into account (Carr and Tyson 1992). The indirect costs are costs concealed in other categories, such as overhead. For example, the costs of handling product 'A''s hazardous waste is an indirect cost if it is allocated to general overhead on product 'A', 'B', and 'C'. The intangible costs are the opportunity costs associated with the 'defective' product. Again using electronic equipment as an example, there is the opportunity cost of a customer buying a more easily recycled product from the competition.

These opportunity costs can be substantial. In the general quality context these can be as high as three to four times that of out-of-pocket failure costs (Brown and Kane 1984).

There is an accepted classification of quality costs as either voluntary or involuntary costs. Voluntary costs are made up of prevention and appraisal costs (see Figure 1), and involuntary costs are made up of internal and external failure costs (Talley 1991: Figure 6-2; Edmonds et al. 1989). Internal costs apply to those that are dealt with in-house and external costs are those that make it to the marketplace and are returned.

In terms of environmental quality costs, appraisal, detection, and prevention costs are essentially the costs of maintaining and monitoring the environmental management system or protection program. This includes audit and inspection costs and staff training costs.

Failure costs stem from internal and external failures. Internal failure costs are those costs which have resulted from less than 'optimal' environmental performance: waste tipping fees over and above those considered to be necessary; and resource use similarly considered 'excessive.' External costs are the estimated contingent liability costs along with the opportunity costs incurred as a result of 'poor' environmental performance.

Another internal failure cost, which is involuntarily assumed, would be the inefficient use of electrical energy, and an external failure cost would be a fine levied by a government agency for the violation of an environmental regulation. As the firm enhances environmental protection efforts (i.e., prevention costs), external and internal failure costs diminish to zero. In Figure 1, protection and appraisal costs grow exponentially as the firm improves its environmental record.

The problems with existing quality cost reports are worth noting as they have bearing on the analysis of environmental quality costs. Morse (1993) has identified five such problems:

1. Much of the information is subjective.
2. Important costs, such as opportunity costs, are omitted.
3. Overhead waste cost assignments may be imprecise. Should overhead waste allocations made for external reporting purposes be included in the cost of waste? Some think that these overhead costs will be canceled by the increased overhead costs which will be attributed to, for example, prevention.
4. Quality costs may not be relevant between periods of differing levels of activity.
5. Effort and accomplishment may take months to pay off.

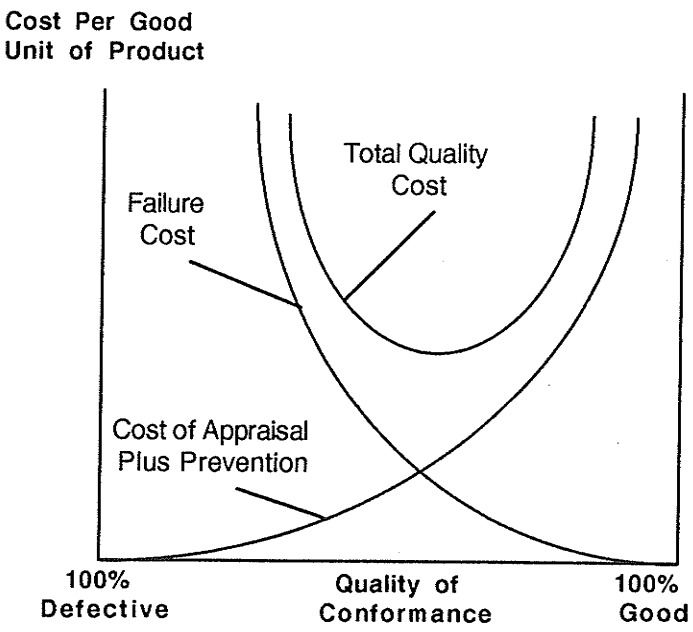

Figure 1: Juran Model of Quality Costs (Carr and Tyson 1992)

2.4.6 Determining the Optimal Amount of Quality Costs

When considering whether to measure quality costs, one is confronted immediately with the skepticism of Edward Deming, who thinks that attempting to measure the costs of quality is a "waste of time" (in Rust et al. 1994). Morse (1993) concurs, pointing to the dynamic nature of quality relationships and the difficulty in precisely measuring the costs.

However, the question of how much should be spent on quality control is worth asking (Carr and Tyson 1992), and this is no less the case regarding environmental costs. Determining how costs actually behave will allow for better policy-making. Looking back at Figure 1, it may appear that the firm should spend up to the point where the total costs of quality are minimized. This was the view up until recently (Edmonds 1989; Broh 1982), although it may be incorrect (Rust et al. 1994). What if, as Carr and Tyson (1992) point out, prevention and appraisal costs are only a small portion of the total costs? Such may well be the case as traditional cost systems have tended to focus only on direct costs (Nandakumar et al. 1993). The thrust of the argument set out by Carr and Tyson (1992) is that failure costs are generally underestimated when a quality cost assessment is made. This underestimation may promote and encourage behaviour that contradicts corporate strategies with regard to efficient resource

allocation and consumption (Myers 1993). Such an underestimation may be even greater in the case of the assessment of environmental quality costs. This is because contingent liability costs and opportunity costs can be very large, and are seldom estimated.

Figure 2 shows a different set of cost curves than those traditionally used in quality system costing. With no minimum total cost appearing before the 100 percent 'defect' rate, the effect that the acceptance of this model will have on corporate policy should be clear: there will be no point at which the firm has optimized its defect rate or, in this research case, degree of environmental protection. A firm must therefore continue spending money on appraisal and prevention, and will not have justification for curtailing its attention to quality improvement. If this is indeed true, it would benefit corporate strategists anyway. This is because the failure to pursue the highest 'quality' undermines not only the spirit of TQM but also the spirit of due diligence. This latter point may be critical when a company is brought before the courts, for if they believe that a company has had no eye to continued improvement, higher penalties, thus higher failure costs, may result.

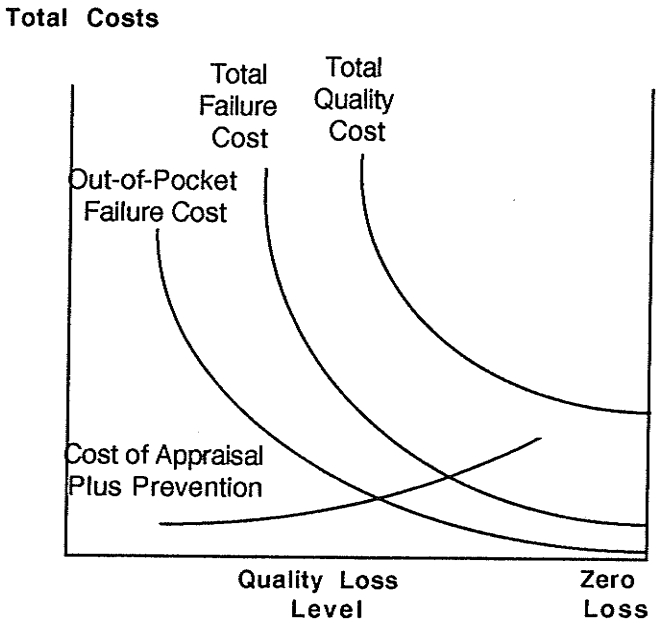

Figure 2: Revised Model of Quality Costs (Source: Carr and Tyson 1992)

There are, then, a number of strategic approaches to choose from for a company in pursuit of quality. (1) Adopt the classic cost of quality model [Figure 1], (2) focus on the reduction of failure costs, (3) underscore non-financial, "hard" statistical process control numbers, or (4) concentrate on output measures of conformance [Figure 2](Carr and Tyson 1992). It

seems that approaches to environmental protection tend to be centered around number one, given many managers' apprehension around environmental issues. This is not surprising given the philosophical debate over the issue of when social costs become a firm's costs (i.e. private costs).

The implications which result from Nandakumar et al.'s (1993) analyses are that a corporate environmental policy should be centered on number four, a concentration on output measures of quality conformance. Their stochastic dynamic programming analysis points to conditions under which this policy is optimal. The first is when there are high levels of capacity utilization and the second is when high costs of internal and external failure may occur. Such high costs might be the case, for instance, in the event of an accidental spill of a hazardous chemical that is used in day-to-day production. Therefore, an environmentally 'risky' firm is one which should pursue 'zero defects.'

2.4.7 Environmental Quality Cost

What remains is the identification of the cost components of environmental quality and the other accounting methods previously discussed. Beginning with environmental quality costs, we see that they are the combination of failure costs—contingent liability and opportunity costs—and prevention and appraisal costs—the costs of establishing, implementing, and monitoring the environmental management system or plan.

2.4.8 Contingent Liability Costs

Another group of costs which traditionally have not appeared in financial statements are those relating to the occurrence or non-occurrence of future events. These are contingent liability costs. Section 3290.02 of the Canadian Institute of Chartered Accountants *Handbook* defines contingency as "an existing condition or situation involving uncertainty as to possible gain or loss of an enterprise that will ultimately be resolved when one or more future events occur or fail to occur." Kreuze and Newell (1994) define contingent liability costs as "penalties and fines for non-compliance and legal claims, awards and settlements for remedial actions, personal injuries, and property damage for future routine and accidental environmental concerns". A contingent liability is thus a temporally-elusive debt owed to outside parties.

A contingency may be represented by the standard probabilistic situation in Figure 3, which is essentially a model for determining expected value. E represents the occurrence of a future event and E' the non-occurrence of that event. Xf and Xu represent both favourable and unfavourable outcomes conditional upon the occurrence or non-occurrence of E. In our case, suppose that E represents the confirmation that a charge has been laid against the firm. The probability of this occurring is π. The outcome of this charge may be no monetary penalty, Xf, or a less favourable outcome, a penalty, Xu. Xf and Xu are conditional upon the probability of incurring the penalty, p.

If estimating the company's cost of regulatory compliance is difficult, as Holman *et al.*'s (1982 & 1985) work suggests, estimating the cost of non-compliance is even more difficult. As commentators working in this area have found, quantifying such a debt or cost is not an easy task (Goodman 1994; Kreuze 1994; Rust et al. 1994).

For the accounting professional, there is a fundamental conflict in any subjective estimation. On the one hand, "financial reporting should provide information to help present and potential investors and creditors and other users in *assessing* the amounts, timing, and *uncertainty* of prospective cash receipts" (Financial Accounting Standards Board (US) SFAC No. 1, para. 37, emphasis added). On the other hand, "the accountant is obliged to adhere to the tests of consistency and professional consensus" (Mock and Vertinsky, 1985).

However, this conflict is only problematic in the case of external reporting. In reporting to the public in financial statements, there is the possibility that the person preparing the information is doing so in a manner favourable to the firm. For instance, if the accountant believes that his or her company will face a fine of $1,000,000 for negligence, and he or she knows that the fine will be raised if this amount is stated in the company's financial reports prior to the court's decision, he or she would be better off understating the amount. In the case of internal reporting, on the other hand, the use of estimation is desirable and is not so greatly influenced by biases or subject to conflicts of interest. It is reasonable then to estimate the amount of an environmentally-related contingent liability if the figure is to be used only for internal purposes.

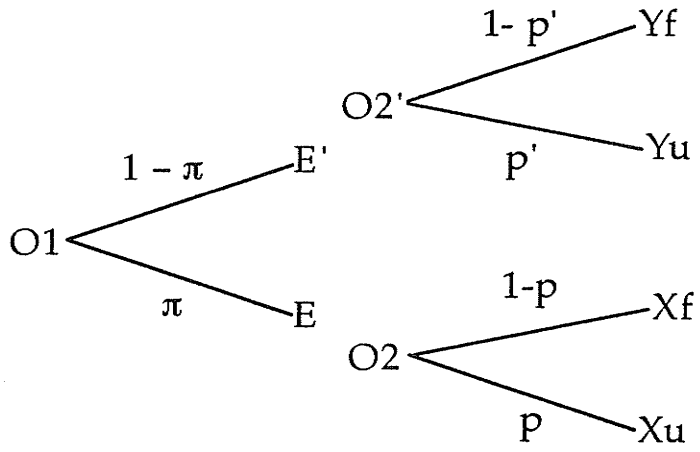

Figure 3: Contingency Decision Tree (source: Thornton, 1983)

Besides the costs one normally associates with contingent liabilities, i.e. penalties, fines, performance orders, etc., there is an additional type of contingency known as the contingency of change. The contingency of change relates directly to those liabilities mentioned above in that as time progresses, costs increase. True, economists have shown that a dollar today is worth more than a dollar tomorrow; but few would disagree that in most instances current environmental costs are rising more quickly than the dollar is falling.

Perhaps the contingency that is most worth addressing is that which is now costing many industries the most amount of money, contaminated site restoration. Consider the situation in the United States, a jurisdiction not entirely unlike our own:

> " out of a universe of 425,000 potential National Priorities List sites, a mere 15,000 are ultimately listed for clean-up. The resulting cost will range from $675 billion to more than $1 trillion." (Cheek 1989)

Today, site contamination is limited more or less to the property on which operations were carried out. Tomorrow may see a host of new responsibilities for a firm, if these responsibilities are extended to the water which flowed from the operation or the air which drifted across it. In other words, the word *site* may be redefined in the near future.

2.4.9 Opportunity Cost

Another cost besides the contingent liability cost which must be eventually factored into the full cost of a product, process, or activity is the opportunity cost. The term *opportunity*

cost is used from time to time in this study and is important in considerations of human interaction with the environment. An *opportunity cost* is the potential benefit that is lost or sacrificed when the selection of one course of action makes it necessary to give up a competing course of action (Garrison 1988: 46). Rapid depletion of a non-renewable resource imposes an opportunity cost on future generations.

It would seem that the only costs that the firm internalizes are those that appear somewhere in the company's financial statements. With respect to environmental costs, such internalized costs may include pollution abatement technology, contaminated site remediation, and compensation to members of the community who were injured as a result of the company's operation. However, it can be argued that there are costs that the company internalizes which do not show up in the company's financial statements. Again, with respect to the environment, these include lost revenue as a result of a customer buying elsewhere: (1) due to negligence on the company's part—for example, Union Carbide in Bhopal, or (2) due to the failure of the company to be perceived by the customer as a 'green' company—such as The Body Shoppe. These implicit, internal costs also include the cost of having to borrow capital at high rates, if banks perceive the company to be environmentally 'risky', and the foregone benefit of a tax deduction offered by the government to those implementing pollution abatement technology, reducing their energy use, or investing in environmental preservation or restoration projects.

Therefore, it is important to consider not only the costs that appear in the financial reports, but also those that do not—a business internalizes both. Again, opportunity costs must now be considered, especially "if we are to move from the accountant's view of profit to the economist's view of profit" (Kempner 1987: 359)—keeping in mind that legislation is policy and economists are policy makers.

2.5 Capital Budgeting

The previous discussion of systems of accounting by-and-large concerned methods of accounting for day-to-day or on-going costs. However, many of the most important financial decisions related to environmental protection involve one-time investments, such as liquid effluent treatment, stack scrubbing, energy efficient machines, etc. To be sure, these investments involve on-going costs; nevertheless treating one-time expenditures necessitates an understanding of what is known as capital budgeting.

Capital budgeting procedures are those procedures related to investment decision-making. Kempner (1987) sees these procedures as consisting of four components:

1. the search for necessary and desirable projects
2. the evaluation of feasible projects and the specific projects to be implemented
3. the agreement of the amount to be invested in each accounting period
4. the economic and financial 'auditing' of past investment decisions so as to improve future ones

The criteria used for evaluating the desirability of projects consists of both qualitative and quantitative criteria. Some of the qualitative criteria in a manufacturing facility involve the shop-floor manager's estimation of need and some involve decisions made by executive personnel, for instance, a decision to eliminate the use of CFCs. Quantitative criteria appear to be the more common and preferred criteria (Brealey *et al.* 1986: 11), and they include budget allocations as a proportion of department size, rate of return, payback period, and the discounted cash-flow methods of net present value and internal rate of return. The method preferred by many businesses today is the discounted cash-flow method of net present value.

2.6 Strategic Cost Management

Conducting the capital budgeting exercise produces information which allows the decision-maker to see if an option provides net benefits for the company. However, it is not correct to say that when a cost-determination exercise is conducted it is conducted within the context of a capital budgeting *system*. Rather, the capital budgeting exercise is conducted as part of a strategic cost analysis, the purpose of which is to ideally "develop and identify superior strategies that will produce a sustainable competitive advantage" (Hansen *et al.* 1995:664). For this reason, when referring to the method or system used to evaluate "go/no-go" decisions, this practicum will refer to *strategic costing*.

A strategic cost analysis produces information that is valuable to a firm not because information is gathered, but because of the way the gathered information is used. Suppose, for example, that a company sets out to measure its costs of quality, i.e., prevention, inspection, appraisal and failure costs. Once it has compiled this information, management will set out to reduce its costs in each of these categories. However, from a strategic point of view, merely reducing costs under each category may not be in the company's best interest. It may be better to focus on the major cost components alone. For instance, many companies would benefit from

solely addressing failure costs, which tend to be surprisingly large. Similarly, a company may obtain environmentally-related cost information, be surprised at the extent of some of the costs, and benefit from solely addressing certain costs.

2.7 Summary

This chapter reviewed a wide array of topics in order to lay a foundation for this research. This foundation is based on what drives a company toward establishing environmental initiatives, the concept of systems management, the laws and standards which govern the firm's EP program, and the methods of accounting for cost and evaluating investment decisions.

Some conclusions are drawn from this review. First, environmental costs can be substantial to the firm (and even the individual in the firm). Second, it is doubtful that there is currently a way of *measuring* the optimal expenditure of these costs so as to realize the maximum benefit from environmental expenditures. Third, environmental management systems are in a stage of infancy, and thus are in need of attention. Fourth, there is a lack of attention by most corporate cost accounting department to environmental issues. Fifth, environmental quality is a form of quality in general, and similarly environmental quality costs are a form of quality costs.

Chapter 3 - Environmental Management and EP Cost Accounting Method-Feasibility at Northern Telecom

3.0 Introduction

This chapter begins with a brief review of the current state of environmental management at Northern Telecom, focusing specifically on the Wireless Networks Calgary (WNC) environmental management system initiative. This review allows the reader to see the context in which the EPC framework was developed and the 'method-feasibility discussions' conducted.

3.1 Environmental Management

At Northern Telecom's corporate level, environmental management strategies have evolved over time (See Figure 4). Currently the company is involved in the development and implementation of corporate-wide environmental management systems (EMSs). These are based on NT's recently released CS 7000 EMS standard. Key to this development was the identification of a number of primary and secondary pilot sites for the testing and validation of the EMS standard. One such secondary site is WNC. In the very near future, NT corporate strategists will be 'rolling-out' the EMSs across the company's business units (NT: Environment and Ethics 1994).

To understand environmental management as it exists at WNC at the current time is to understand the current state of WNC's EMS. The EMS developed for WNC was designed to comply with both the general requirements of British Standard BS7750 (Appendix 4) and the specific requirements of the Northern Telecom EMS standard CS 7000. As such it is comprised of a number of stages, as shown in Figure 5.

By the end of the summer of 1994, WNC had prepared the Register of Regulations and Register of Environmental Effects and had begun the preparation of a Management Manual wherein were to reside a number of operational procedures needed for compliance to the standard. At the time of writing these procedures had not yet been developed (the required procedures are listed in Appendix 5)

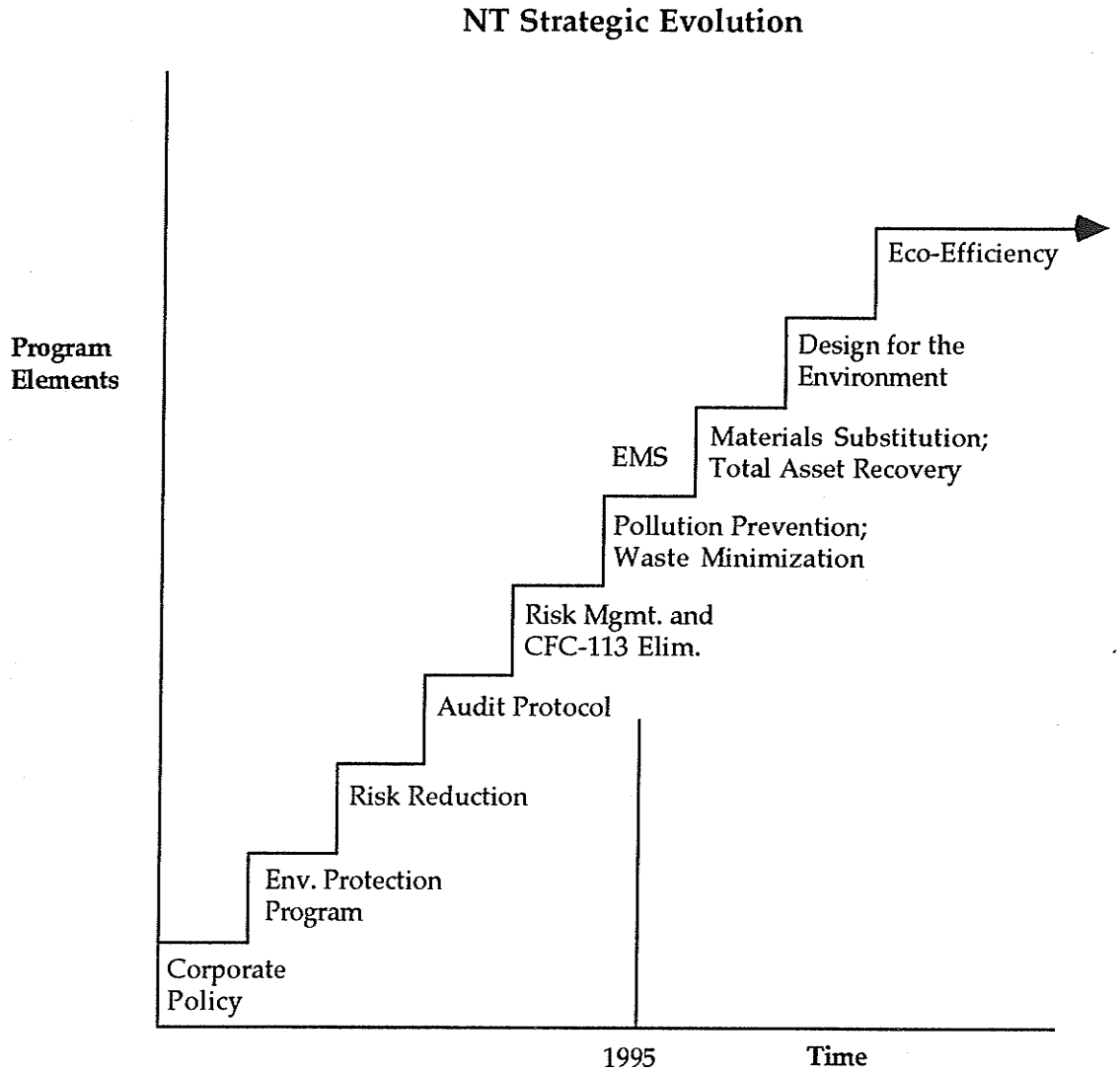

Figure 4: NT's Evolution of Environmental Strategies (Source: Northern Telecom 1994)

There are a number of possible reasons why the operation's management put the further implementation of the EMS on hold, the determination of which is outside of the scope of this paper. Notwithstanding, it seems reasonable, given the preliminary arguments in this paper, that the failure to carry out the implementation of the EMS at WNC may be due in part to the inability of management to justify the costs of implementation.

A further important point to note is that the combination of NT corporate's assignment of WNC as a pilot site—which induced WNC on to carrying out an EMS initiative—and WNC's autonomy resulted in WNC beginning its EMS at an intermediate stage. In a sense, from WNC's point-of-view, the EMS was treated as both a system for all of NT, and at the same time a system for only WNC. This may have negative consequences for WSC's EMS, as many

commentators (*viz.* Rothery 1993) point out that formal, top-level management commitment must precede system development.

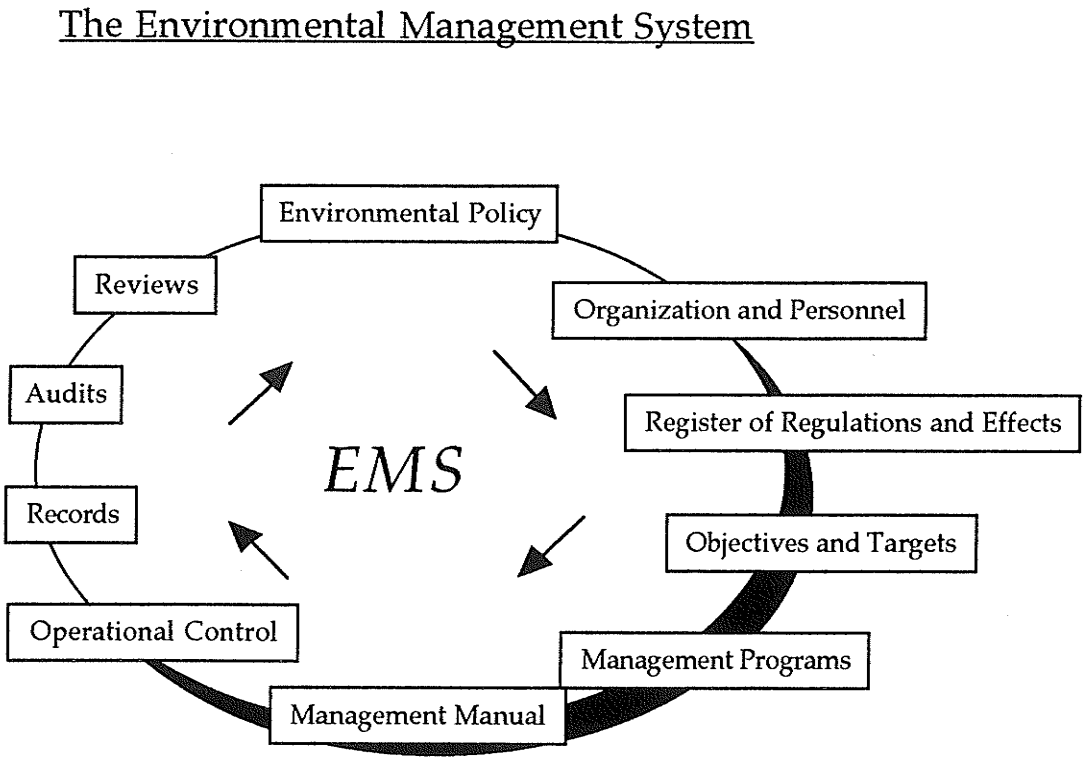

Figure 5: The Environmental Management System (Source: Northern Telecom 1994)

3.2 EP Cost Accounting Method-Feasibility Discussions

The operational issue to be addressed is how EP costs will be determined and handled. What is the most appropriate method of handling these costs and who should determine them? The use of traditional managerial accounting techniques appears too limited. An attempt to account for full costs appears very difficult, as it is certain that there will be disagreement on the size and certainty of the cost. Perhaps quality costing or activity-based costing offers the

best answer. Finally, what environmental considerations should or can be included in investment decisions? And what evalutory criteria are to be selected for this determination?

These questions and issues cannot be solved within the context of the academic environment alone, so they were put to a number of individuals in the client firm. This enabled the researcher to not only 'pragmatize' the research, but also to design and suggest a framework that will allow the client firm to incorporate and control its own EP costs.

In this section the results of the interviews held with various members of the client firm are discussed. The questions posed by the researcher were designed to stimulate discussion rather than elicit yes/no responses and were of a general nature. They basically asked the following:

- How does Wireless Networks Calgary (WNC) currently account for environmental protection costs?
- Comment on the applicability and appropriateness of the activity based costing, quality costing, and contingent liability costing methods of accounting for EP costs as I have presented them in the handout (see Appendix 3)
- What information would you need to help you account for environmental protection costs and who should provide it?

The interviews were conducted in-person over the course of the week of February 11-17, 1995 at Northern Telecom's WNC operation. The following individuals' responses were obtained and documented. Their titles are followed by two figures: the first represents their time in years with Northern Telecom; the second their time in years in the current role.

- Manager of the Quality department, 20/4
- Accounting specialist in charge of developing and implementing activity-based costing, 1/1
- Manufacturing Engineering engineer in charge of Capital Funds Appropriation preparation (i.e., the capital budgeting exercise), 3/1
- Resource Protection specialist, 7.5/1

These individuals' responses are ordered according to the above list for each of the following subject categories: existing methods of accounting for costs, quality cost accounting, activity-based costing, contingent liability accounting, capital funds appropriation, and general comments.

3.2.1 Existing Method of Accounting for Costs

- Manager of the Quality department

The Quality manager, when asked about the manner of accounting for his department's costs, stated that the Quality division receives only "enough to maintain and work toward improvement." Further, he said, there are no excess resources.

- Accounting specialist

At the present time Northern Telecom's WNC operation does not account for its EP costs *per se*. The Resource Protection division does record the part of the Customer Satisfaction department's budget that it receives and broadly categorizes its costs among health, safety, and environment activities; however no further disaggregation occurs. Similarly, the quality division receives a portion of the Customer Satisfaction department's funds but costs are not tracked for specific activities.

- Manufacturing Engineering engineer: No comment in this area.

- Resource Protection specialist:

The Resource Protection department's costs are not tied to any specific performance criteria. The costs are considered part of general overhead and the budget is based on previous period needs and projected changes.

3.2.2 Quality Cost Accounting

- Manager of the Quality department

The quality manager said that the quality cost model would be useful for management purposes, although he preferred the ABC model for operational purposes. Concerning one appraisal cost, auditing, the quality representative pointed out that auditing costs must be broken down among the costs of the audit of documentation and the costs of the audit of compliance to documentation, so as to make the EP system compatible with that of the quality system. Further these two types of audits are not conducted with the same frequency, the former being conducted once a year and the latter ideally quarterly. These distinctions were lacking in

the quality cost model presented to him. Nor did the quality model identify the one-off cost of establishing the documentation, which can be significant.

There is also the current belief of the quality manager that audits are a cost of doing business, and this is why they are relegated to general overhead. Audits for compliance to documentation, he points out, are currently being conducted by corporate rather than location auditors, and this makes tying these costs to a specific activity difficult.

It is this differentiation between operational and corporate responsibilities that precludes determining which of the two cost of quality models (see Figures 1 and 2) is correct overall. The quality manager suggests that it may be possible to optimize EP costs at the operational level; but not at the corporate level. This is because the external and internal failure costs are much more significant at the corporate level. Opportunity costs of alienated customers, and litigation involving corporate council are neither immediately nor directly felt by an operation.

The issue of prioritizing the various quality costs arose in the discussion with the Quality manager. He suggested looking at and addressing the most significant failure costs first. These would be determined, as is typically the case, intuitively.

Another suggestion given by the Quality manager is that the relationships between failure and prevention/appraisal costs be established. For instance, how does documentation or product design relate to defects? What is the cause and effect? Would overall environmental awareness have a large effect on environmental 'defects', as he thinks it would? Would failure costs decline in a stepwise fashion as a technological breakthrough such as CFC substitution occurs?

- Accounting specialist: No comment in this area.

- Manufacturing Engineering engineer: No comment in this area.

- Resource Protection specialist

The Resource Protection representative stated that failure costs have attendant support costs which should be considered.

3.2.3 Activity Based Costing

• Manager of the Quality department

While not discounting the utility of the quality model for environmental purposes, the quality manager preferred the ABC model for "action," or operational purposes. He criticized ABC on only one count: that it is reactive in nature. Reliance on such a tool, he stated, only addresses the symptoms and not the causes.

• Accounting specialist

It is necessary to describe how NT WNC currently carries out activity-based costing. NT follows the method of identifying and then assigning cost drivers, whether these cost drivers are related to costs of activities or resources. Not all firms aggregate related micro activities into macro activities. Further, those that do aggregate related micro activities into macro activities tend to compile cost information for micro activities. NT does not compile micro cost information, and this is where NT may be unique. According to her, at the current time, micro activities do not have monetary costs assigned to them; rather cost figures are assigned only to macro activities. Also significant is the fact that the Resource Protection department conducts neither micro nor macro analyses; all costs are allocated to WNC's general overhead.

The reason given as to why ABC is not carried out in the Resource Protection area is simple, according to accounting: the benefits that could be derived from having the data outweigh the costs of obtaining it. However, some information is available that will allow ABC to be used for EP cost accounting purposes. First, quality costs for specific activities relating to all indirect support at WNC is obtained. Second, attachment of the above costs to product families is carried out.

The accounting representative identified some of the barriers that might prevent the use of ABC in accounting for EP costs. First, ABC only accounts for costs directly related to indirect support *inside* the building. Second, ABC is useful only if activities are linked to the appropriate drivers and these drivers can be quantified and forecasted. Third, ABC is only as accurate as the information which is provided by the department. Fourth, acceptance of ABC data at WNC is still moving quite slowly.

This fourth barrier may be described as a behavioural barrier. Some of the issues that should be considered under this topic, as noted by accounting, include:

- senior management buy-in
- determination of the benefits to individuals
- acceptance occurs only gradually
- visibility of the issue must be high
- the best possible data with the minimum amount of support is a necessity

It must be mentioned here as a conclusion to the discussion of ABC, that value-chain analysis, which adds a temporal dimension to ABC, is also beginning to be used by NT Corporate and NT WNC.

- Manufacturing Engineering engineer: No comment in this area

- Resource Protection specialist: No comment in this area

3.2.4 Contingent Liability Accounting

- Manager of the Quality department

The Quality manager was uncomfortable with this component of the information package handed out to respondents. On the one hand he felt that its use would invoke fear among managers and this could lead to hiding things. On the other hand he did feel it would instill a much needed sense of urgency. If managers' have as their primary aim the reduction of costs, this model will allow EP to be grouped with customer satisfaction and product improvement.

The quality manager also felt that NT should adopt the perspective of the customer when determining how far to go in avoiding contingent liability costs. This he said would currently mean that NT should work toward the 'zero defect' level of EP. Nevertheless he did want to demonstrate that NT is sometimes moved to act beyond the requirements of its customers, using the example of how NT aided industry in its efforts to eliminate the use of freon.

This individual was also able to comment when asked about how one should make the distinction between individual and corporate fines in the Contingency Decision Tree (see figure 1). He felt that the assumption should be made that penalties would accrue to the corporation. However he also said this necessitates that documentation is properly carried out and that roles and responsibilities are clearly delineated. The area of the Contingency Decision Tree

which deals with enforcement elicited the reaction from the Quality manager that 'π' is a critical variable in how a company approaches efforts to avoid penalties.

- Accounting specialist

Concerning the Contingent Liability accounting method, the Accounting representative had only one point. She stated that estimating these costs will be very difficult and that considerable expert knowledge would be needed.

- Manufacturing Engineering engineer: No comment in this area

- Resource Protection specialist

The Resource Protection specialist also commented on the Contingency Decision Tree. He felt that the individual penalty should be used alongside the corporate one to act as a 'shock' tactic. Similar to the Quality manager, 'π', he said, is a critical variable in how a company approaches efforts to avoid penalties. It must be pointed out that neither the quality manager nor the Resource Protection specialist said "how NT approaches..."; rather they said "how a company approaches...".

In addition, the Resource Protection specialist perceives that 'π' is moving toward '1' in his industry, which implies that enforcement activities are increasing. Lastly, the Resource Protection representative stated that the Risk Factor Determination exercise (see forward Figure 8) does not account for how quickly a company is moving toward compliance.

3.2.5 Capital Funds Appropriation

- Manager of the Quality department: No comment in this area

- Accounting specialist: No comment in this area

- Manufacturing Engineering engineer

Some EP costs that the manufacturing engineer would like to see factored into the Capital Funds Appropriation (CFA) are the costs of waste disposal, staff training if the chemical is new, and transportation and handling costs. However, the CFA form currently asks for only certain things, and they do not specifically include any of the above costs. As it is, if the item is not in the department's budget, it is not to be included in the CFA analysis. An

example he used was worker's compensation payments. These are the responsibility of the corporation, not the operation, so how could they be factored into decisions?

Not only does a lot depend on whether responsibility for the item is corporate or operation, he states, but also a lot depends on the person who receives the CFA form. This audience, he points out, can be very subjective. Two possible ways of avoiding this subjectivity were identified by him. One would be to conduct a poll of employees to obtain a group consensus on what the environmental priorities should be. The second way of reducing subjectivity would be to rely on precedents and past decisions. This point relates to industry standards, a type of precedent, which now exist on the use of CFCs and Volatile Organic Compound (VOC)-free fluxes, he observed. Lastly, he also stated that there is a distinction between items governed by legislation, such as chemicals, and those governed by cost, such as energy. Yet both of these are included in the CFA form.

The question was also asked of the manufacturing engineer if it would be possible to use a factor as opposed to a dollar figure when estimating costs. On this he felt that verbal descriptors would be the most useful. For instance a CFA should allow the analyst room for words like 'improves' or 'minimizes'. This would eliminate the high degree of uncertainty in numerically estimating costs which are difficult to quantify, such as many of those related to ergonomics.

- Resource Protection specialist: No comment in this area

3.2.6 General Comments

- Manager of the Quality department

In general, the Quality manager believes, many costs are very difficult to track, and often intuitive knowledge is needed and used in their estimation. This is due to what he referred to as the length of the value chain. Take for instance the costs of quality; eventually WNC runs out of 'safety nets' along the value chain—such as warranties, guarantees, and free service—and costs escape estimation. Such could be the case for EP costs he pointed out, as it would be difficult to factor recycling costs into product prices. Recycling is at the far end of the value chain and most likely these costs would be incurred by a separate business. Again much depends on the scope of the costing activity.

The Quality manager emphasized the importance of focusing on the effect that proper product design has on EP costs. He used the example of a current production process that utilizes 100 percent robotics. In that operation, he said, there are no quality defects to speak of. But that is only possible because of the attention paid in the design process; standards were written and used and designers paid close attention to quality. He wondered if there was a standard, or could be a standard, used in designing for environmental protection.

The Quality manager also emphasized the importance of stimulating awareness about environmental issues in order to improve performance. The very act of documenting the quality system had a tremendous impact on the defect rate at WNC. He attributes this to the 'marketing' of quality; many employees for the first time became aware of the need for quality.

The question was also asked of the Quality manager "who do you think should cost EP?" He answered that it should be up to those that understand the costs and those who establish the system. Although it is everyone's overall responsibility, he felt that Resource Protection seemed to be the group to take charge. He went on to state that once the desired behaviours become standardized, the initial team could be disbanded. The manufacturing engineer added a point here that magazines and trade journals should be regularly examined and conferences attended as they are likely a good source for acquiring knowledge about EP costs.

- Accounting specialist: No comment in this area
- Manufacturing Engineering engineer: No comment in this area
- Resource Protection specialist: No comment in this area

3.3 Summary

At the corporate level, NT demonstrates an awareness of the need for environmental strategies and has an ability to reformulate these strategies as time goes on. However, because NT locations operate with a high degree of autonomy, initiatives such as WNC's EMS system lack a certain amount of needed support from corporate headquarters. It is possible that this lack of support exists elsewhere at WNC. Specifically with respect to environmental matters, this would explain WNC's hesitancy to continue with its EMS and the less-than-high level of awareness regarding environmental matters among WNC employees.

Turning to the method-feasibility discussions, it can be seen that the amount of information provided by the respondents is highly uneven. There were two apparent reasons for

this. First, there was the individual nature of each of the respondents; some are more given to discussion than others. The second reason is more significant. While each representative had quite a bit to say about their respective areas—accounting about ABC, quality about quality, etc.—only the manager of the Quality department was able to view the company in the bigger picture. This may have had a lot to do with his senior status, but it is thought to have had more to do with the nature of the department, which is vested with the responsibility of making WNC a 'quality' operation.

It was expected that the Resource Protection specialist would have had more input; however, this individual was only in this position temporarily, which must have had the greatest bearing on his ability to provide only limited input. Also, it appears that there is little motivation for a WNC employee to enhance the company's environmental performance, through either action or suggestion.

Chapter 4 - The Environmental Protection Cost Framework: Development and Evaluation

In this chapter, an EP cost framework is suggested and explained and the framework is operationalized and evaluated. Thus chapter 4 moves us from the "normative to the practical realm." This chapter combines the information provided in the literature review with that obtained from information in the client firm. The objective to be fulfilled here is to produce a visually representative model or framework, which all individuals in the client firm that are vested with the responsibility of accounting for cost or making investment decisions can use as a tool to assist them in the incorporation of EP costs into WNC decisions. Having developed the framework, it is then evaluated through its application to an unresolved issue within the client firm.

4.0 Customizing the EPC Framework

WNC, as is apparent from the information provided by the interviews, has specific needs and requirements for its cost accounting system. The most obvious trait of WNC is its use of activity-based costing (ABC) as a supplement to management accounting. This is clearly advantageous, as ABC is proving to be an effective tool for use in attaching environmental costs—costs that have hitherto been lumped together to form part of most operations' general overhead. ABC is planned to be used at WNC for accounting for costs in the quality department as well. That quality costing may or may not be superior for the purposes of accounting for quality costs is therefore a moot question at the present time. NT and WNC are pursuing ABC in an aggressive fashion, so quality costing will not be included as part of the framework.

4.0.1 The Framework

The EPC framework as it is intended for use by WNC decision-makers is shown in Figure 6. These individuals could be from any one of a number of different areas in the operation: design, procurement, quality assurance, engineering, information management, human resources, manufacturing, facilities maintenance, warehousing, finance, accounting, or resource protection. The only requirement is that they are making a decision which could affect the physical environment and thus impose a cost on the environment and, indirectly, on society. The framework is a tool for stimulating awareness and creating an understanding of the environmental issues associated with WSC's operations. As such, it should be readily available to the decision-maker and used on a regular basis.

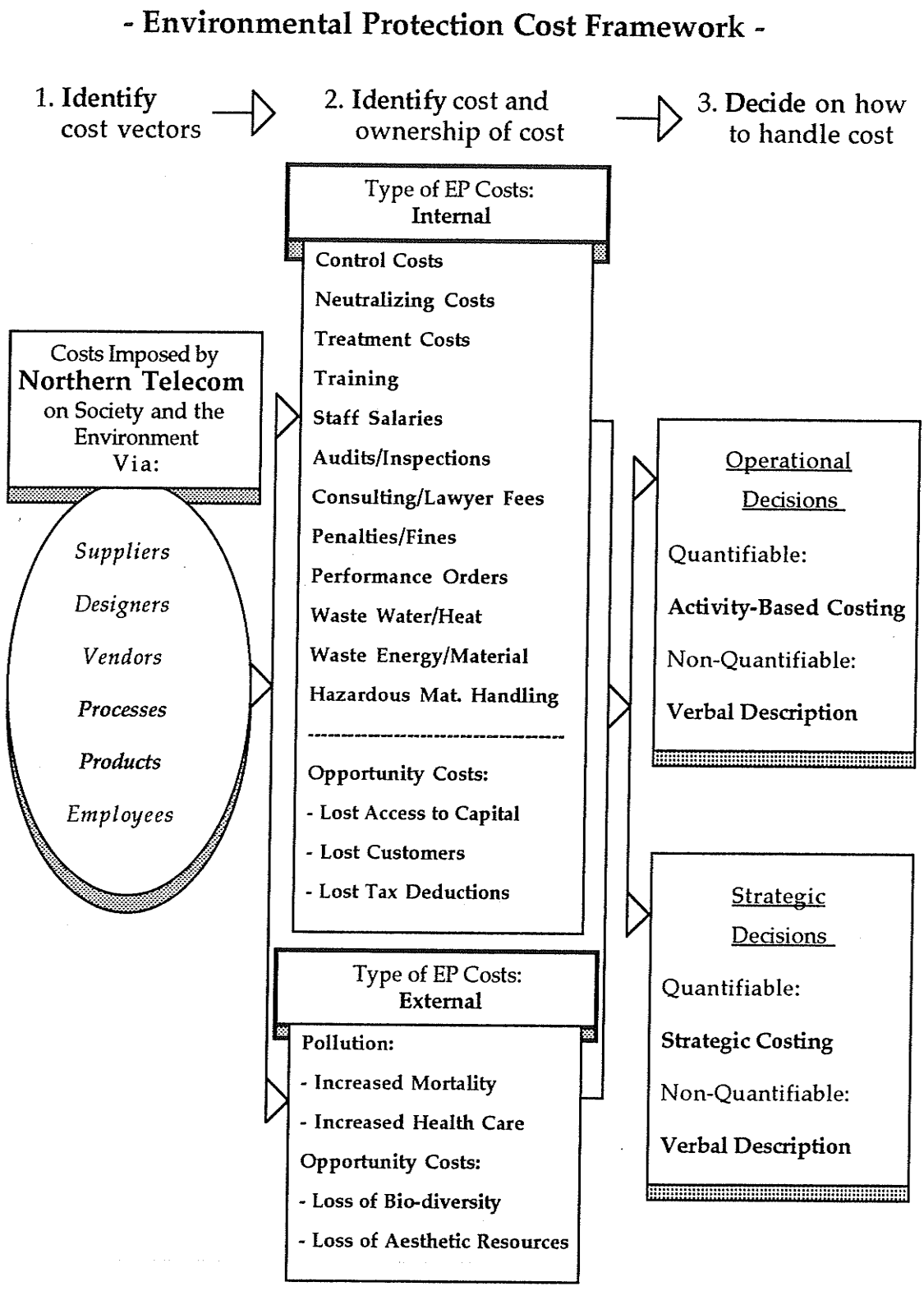

Figure 6 - The Environmental Protection Cost Framework

The EPC framework reads from left to right, according to the process of: identifying cost vectors, identifying the cost and ownership of the cost, and then deciding on how to handle the cost. At each of these three steps the decision-maker asks certain questions.

Step 1. Identify cost vectors.

Q. Looking at the list of entities under item 1 in the framework, the decision-maker asks the question: if a given option is followed, WNC will impose costs on society and/or the environment through which entities: suppliers? designers? vendors? etc.

Step 2. Identify cost and ownership of cost.

Q. Looking at the list of costs under item 2 in the framework, the decision-maker asks the questions:

(1) of all the possible costs, which one(s) would be relevant if this option is followed?

(2) regarding the ownership of the cost(s), if this option is followed, will the relevant cost(s) be incurred by WNC or passed on to outside parties? That is, which costs do we as a firm capture (internalize)?

Step 3. Decide on how to handle costs.

Q. The relevant costs may be of an on-going or a one-time nature. If they are of an on-going nature, the decision to incur these costs will be made within an operational decision-making framework. If they are of a one-time nature, the decision to incur these costs will be made within a strategic decision-making framework.
The relevant model to be applied in the case of operational decisions is activity-based costing. In the case of strategic decisions, the relevant model to be applied is strategic costing, with its primary analysis procedures of capital budgeting.
Thus, the question the decision-maker asks here is: are the costs of an on-going or a one-time nature?

Also, some costs may be easily quantified and put into monetary terms; others not. Often, with some effort, they can at least be estimated. So to account for costs, the decision-maker asks the question: is the cost quantifiable? If so, then it can treated under either the financial analysis technique of capital budgeting or the cost accounting technique of activity-based costing. If not, the cost should be assigned a verbal or narrative descriptor.

Through this identification and decision process, costs which were previously unrecognized can be brought into WNC's financial decision-making and cost accounting system. Further, by using the framework repeatedly, costs which have typically not been captured (internalized) will be able to be captured, in accordance with the needs and changing perceptions of WNC decision-makers.

4.0.2 Contingent Liability Costs

It was stated above that with some effort, certain costs can at least be estimated. An important consideration in the estimation of many of the costs which face the company is the probability that the costs will be incurred. This is especially important in the determination of the contingent liabilities facing WNC at a given point in time, but it is also important in analyzing the costs associated with such things as financial and environmental risk. However, determining a probability is difficult, and because this determination is a necessary part of the EPC framework, it is dealt with here.

An estimation of a future cost is a product of two parts: an outcome and a probability of that outcome occurring. To estimate, for example, the cost of having to clean up a possible spill of a major chemical, the cost of clean-up is simply multiplied by the probability of occurrence. These probabilities of occurrence vary in each situation, but Covello *et al.* (1988) do provide a list of probabilities of a number of manufacturing-related potentialities.

For estimating contingent liabilities,[5] the method is more involved and so the 'contingency decision-tree' (Figure 7) is reintroduced. Unlike having to ascribe one probability to one outcome as in the above instances, in estimating contingent liabilities two probability figures are needed. These are associated with two different stages, the first being analogous to a charge being laid, and the second analogous to a conviction, based upon that charge, being handed down. An exception to this rule occurs often in the case of smaller charges, such as a violation of a municipal by-law, which typically involve simultaneous charge and conviction—often the case in a fine levied on-the-spot by a by-law officer.

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[5] Interestingly, there is an environmental cost framework offered by the US Environmental Protection Agency. The computer program calculates "the after tax net present value of a pollution prevention or mitigation project and to calculate 'cash-outs' in Superfund cases' (Goeller 1994). This program may be worth examining.

In the case of a major charge, the charge may not result in a conviction. So in assessing the liability, two separate analyses may need to be made: first, what is the *chance* of being charged and, second, what is the *chance* of being fined the maximum amount?

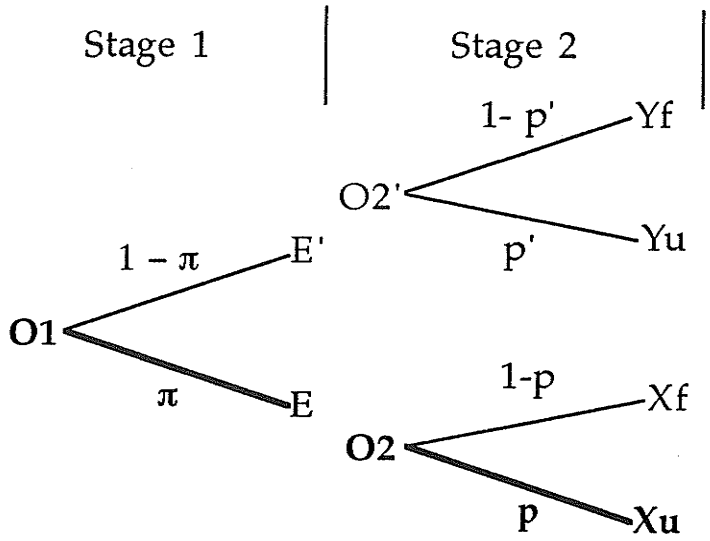

Figure 7: Contingency Decision Tree (Adapted from Thornton, 1983)

The first step toward answering this question is to establish the compliance status of the firm. If the company has an EMS, as does the client firm, this can be relatively easily done.[6] For each out-of-compliance situation a separate contingency decision tree is drawn. A value for π is then derived by arbitrarily determining the level of enforcement in the jurisdiction: π is equal to 1.0 if there is 100 percent enforcement and 0.0 if there is no enforcement. This is how the probability of being charged, π, is determined.

The next step is more complicated. The penalty range must be determined and a probability for each level of penalty given. The highest penalty will likely be dealt out only in the most "egregious of circumstances." Egregious circumstances, it will be suggested, are achieved when all sixteen of Swaigen and Bunt's (1985) 'sentencing factors' (see section 2.3.2.2) are realized. Therefore, one can estimate the exposure to monetary penalty by estimating the likelihood of the enactment of these factors. A decision tree with these factors is provided in the Risk Factor Determination model in Figure 8.

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[6] One of the requirements of the EMS (ISO 14000 1994 draft) is to compile a register of relevant regulations. These may include not only pieces of legislation, but also tort laws, industry and advocacy group standards, and corporate policy. The company's existing situation is then measured against these regulations.

Since this framework is only a rule of thumb and not intended to supply complete information to the decision-maker, it is not appropriate to use an elaborate numbering scheme for determining the probabilities of the enactment of the sentencing factors. For this reason only three ratings will be used: probable, reasonably possible, and remote. A 'remote' rating carries a factor of zero; a 'reasonably possible' rating carries a factor of .33; and a 'probable' factor a rating of .66.

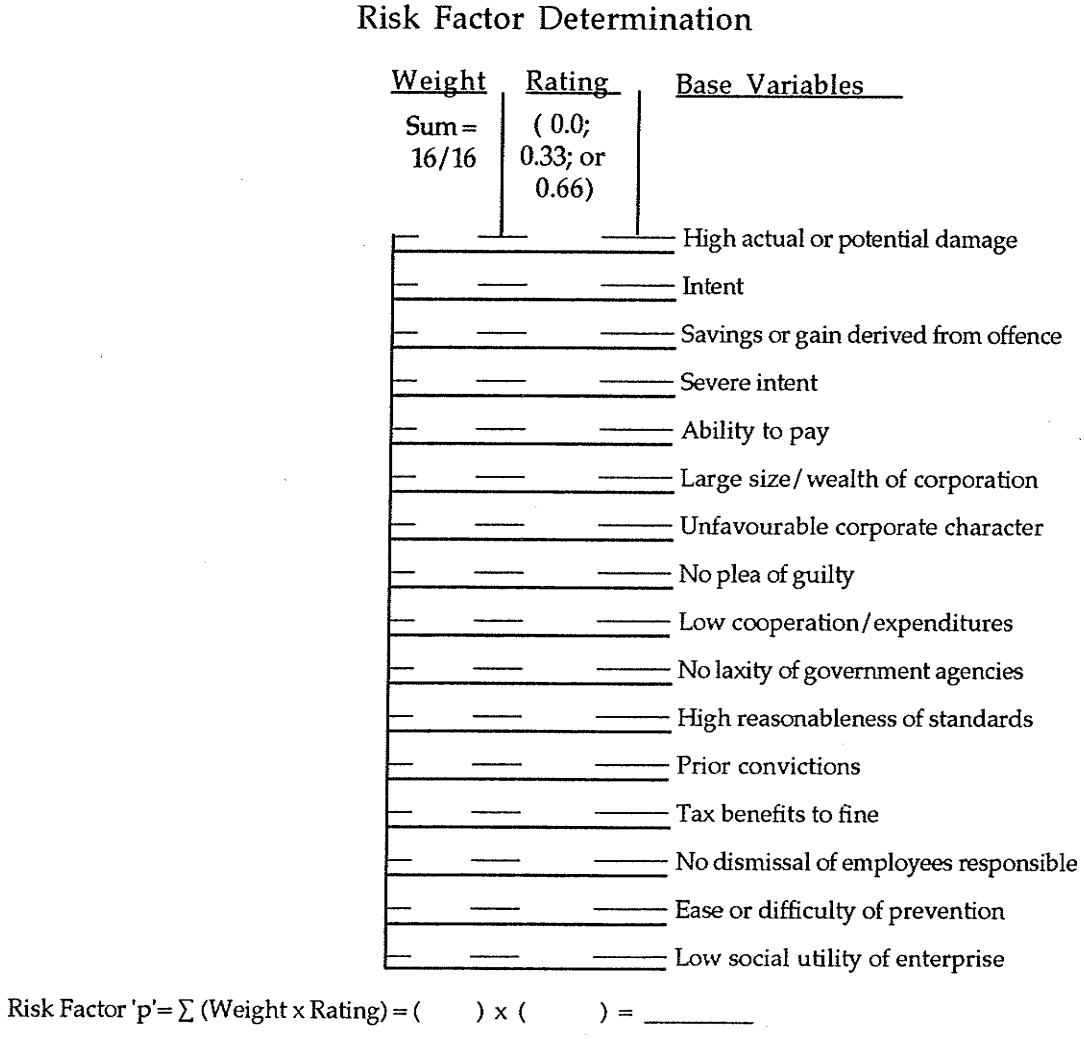

Figure 8: Risk Factor Determination Model (Adapted from Swaigen and Bunt 1985)

Having completed the Risk Factor Determination exercise, the assessor or decision-maker now has a decision variable which is equivalent to the probability "p" shown in Figure 5. This probability "p" is now multiplied by the predetermined maximum penalty "Xu" and

this gives an expected outcome "O2." Finally, π is multiplied by the expected outcome "O2" to give "O1." "O1" is the contingent liability cost for that regulatory issue.

There are obvious limits to the validity of this method of estimating contingent liability costs. First, it is assumed that the assessor can adequately determine the weight the court will give to the sentencing factors. Unless there exists sufficient historic data, lawmakers and regulators should be questioned in this regard to predetermine the weighting. Second, it is assumed that an additive identity holds for the costs. Suppose the firm is out-of-compliance on ten counts, each of which could result in a maximum penalty of $1000. It is unlikely that the courts would fine the firm the full $10,000. Lastly, there is a certain degree of covariance among the sentencing decision variables. One sentencing decision based on ten counts will not be equivalent to ten sentencing decisions each based on one count. As can be seen, this covariance offsets to some degree the non-additive identity of multiple charges.

In conclusion, the contingent liability cost method, an involved process, is used to estimate the costs facing the firm for such things as penalties, fines, and performance orders—items found on the right-hand side of the EPC framework. It is not limited to these items alone, however, as the estimation of a number of items require assigning probabilistic variables to perceived outcomes.

4.0.3 Opportunity Costs

Opportunity costs are in essence the benefits lost by the firm for not improving its EP efforts. These costs may be either on-going—for example the daily costs of being locked out of a trading situation—or one-time—for instance the costs of a product boycott brought about by a firm's decision not to buy back used and discarded components. There are a number of types of opportunity costs and these should be specifically identified. Also, as was pointed out in section 2.4.9, opportunity costs are internalized by a firm whether or not they are acknowledged in a firm's financial statements.

If estimating the costs of contingent liability is difficult, estimating the opportunity costs of poor environmental performance is even more so. The addition of opportunity costs to overall EP costs should eventually be made, no matter how rough the estimation. However, until a higher comfort level in estimating these costs is attained by the evaluator and more information on these costs is provided for use by industry, simply acknowledging these costs using verbal descriptors may be as far as one can go.

4.0.4 Cost Reporting

The operationalization of the EPC Framework requires a certain amount of cost information. Whether for use in activity-based costing or capital budgeting this information may need to be derived from some of the following sources:

1. Salary budget reports
2. Manufacturing expense reports
3. Waste reports
4. Energy use reports
5. Travel expense reports
6. Product cost information
7. Fines and Penalty reports
8. Production labour reports
9. Audit and inspection records
10. Estimates from knowledgeable personnel
11. Costs of establishing EMS
12. Costs of monitoring/maintaining EMS
13. Opportunity cost and other special cost analyses

For this reason, a firm's accounting department will have to ensure its information network can provide this information.

4.1 Evaluating the EPC Framework

Up to this point the task has been to synthesize information about environmental management, environmental law, industry standards, cost accounting, and capital budgeting with information about the WNC operation. The product of this synthesis is the EPC framework just introduced. The task in this section is to operationalize the framework using an issue WNC has yet to address.

4.1.1 A WNC EMS Cost Justification Problem

It was pointed out earlier in this report (see section 3.1) that WNC has developed but not yet implemented an EMS. The most likely reason for this is management's uncertainty as to the net benefit that would result from carrying out any further actions. As such, WNC's EMS implementation decision provides a useful case for the evaluation of the EPC framework. For the sake of brevity, a single requirement was chosen for the application of the framework (see Appendix 5 for a list of the full EMS requirements).

4.1.2 Using the Framework

For the evaluation exercise, the actual analysis can be broken down into two separate components: the costs of developing and implementing the EMS requirement and the costs of not developing and implementing the EMS requirement. The following is a description of the process involved in using the EPC framework as related to the 'materials handling: procurement, storage, and transportation procedure'. While going through this example, refer to the EPC framework as it appears in section 4.0.1.

- Using the EPC Framework:
the Case of Developing the Materials Handling:
Procurement, Storage, and Transportation procedure -

Option A - Developing the Procedure:

Step 1A. Identify cost vectors.

Q. Looking at the list of entities under item 1 in the framework, the decision-maker asks the question: if a given option is followed, WNC will impose costs on society and/or the environment through which entities: suppliers? designers? vendors? etc.

A. In developing the 'materials handling: procurement, storage, and transportation procedure', certain costs will be passed on to society via:

- WNC products: the cost of development and implementation of this procedure will come primarily from the Resource Protection department's budget. Since this department's budget is part of the operation's general administration budget, the costs of this procedure will be allocated across all WNC products, and thus indirectly passed on to all WNC customers.
- Suppliers: By seeing that this procedure is in place, WNC will need to change the way it deals with its suppliers, requiring them to do such things as provide up-to-date Materials Safety Data Sheets (MSDSs) on a more frequent basis and formally ensure that products are being delivered in a safe and socially responsible manner. This may increase the supplier's cost of goods, which similarly will be indirectly passed on to WNC customers.

Step 2A. Identify cost and ownership of cost.

Q. Looking at the list of costs under item 2 in the framework, the decision-maker asks the questions:

(1) of all the possible costs, which one(s) would be relevant if this option is followed?

(2) regarding the ownership of the cost(s), if this option is followed, will the relevant cost(s) be incurred by WNC or passed on to outside parties? That is, which costs do we as a firm capture (internalize)?

A. (1) There will be a number of costs incurred once the procedure is implemented. Under item 2 these costs include: training, staff salary, audit and inspection costs. However, the development and implementation of this procedure requires primarily a one-time expenditure—about $1400[7] in direct salaries going to Resource Protection personnel to develop and implement the procedure. Under item 2 this expenditure can be termed a control cost. It is difficult to say at this time how much time on the part of other WNC employees must be devoted to the implementation of this procedure, but some will be required. No fixed assets such as special computer equipment are needed to develop and establish this procedure.

As far as receiving benefits for the development and implementation of this procedure is concerned, see the opportunity costs, lost access to capital, and lost customers discussion in section 2B below (costs of not developing procedure).

(2) It may be possible that the procedure will be developed for WNC by the parent NT, in which case they will not be captured by WNC. More remote but also a possibility is that an industry association or university will assist in the development of this procedure, and thereby reduce WNC's need to capture the cost.

Step 3A. Decide on how to handle costs.

Q. The relevant costs may be of an on-going or a one-time nature. If they are of an on-going nature, the decision to incur these costs will be made within an operational decision-making framework. If they are of a one-time nature, the decision to incur these costs will be made within a strategic decision-making framework.

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[7] See Appendix 5: 0.5 person weeks of development time plus 1.5 weeks of implementation time equals 2 person weeks required to put this procedure into place. One person week is equal to $700.

The relevant model to be applied in the case of operational decisions is activity-based costing. In the case of strategic decisions, the relevant model to be applied is strategic costing, with its primary analysis procedures of capital budgeting. Thus, the question the decision-maker asks here is: are the costs of an on-going or a one-time nature?

A. Since the costs of developing and implementing the procedure are predominantly one-time, the decision to incur them is made within the strategic decision-making framework. Therefore, they will be handled using the strategic costing 'model', and the techniques of capital budgeting.

Also, some costs may be easily quantified and put into monetary terms; others not. Often, with some effort, they can at least be estimated. So to account for costs, the decision-maker asks the question: is the cost quantifiable? If so, then it can treated under either the financial analysis technique of capital budgeting or the cost accounting technique of activity-based costing, If not, the cost can be assigned a verbal or narrative descriptor.

A. The costs of developing and implementing this procedure are quantifiable.

Option B - Not Developing Procedure:

Step 1B. Identify cost vectors.

Q. Looking at the list of entities under item 1 in the framework, the decision-maker asks the question: if the given option is not followed, WNC will impose costs on society and/or the environment through which entities: suppliers? designers? vendors? etc.

A. In not developing the 'materials handling: procurement, storage, and transportation procedure', certain costs will be passed on to society via:

- Suppliers: By not having this procedure in place, supplier standards for handling materials will not be as high as they would with the procedure in place. WNC would thus be able to reduce the environmental effects (costs) of its suppliers by developing this procedure.
- Processes: If this procedure is not developed, costs may be imposed on society via WNC's processes. The extent of these costs is hard to say; perhaps a closer look at

how materials are handled during the procurement, storage, and transportation stages should be part of an environmental risk analysis.

- Employees: By not developing and implementing this procedure, WNC does less to change the way its employees handle potentially hazardous materials at home and in the workplace. This has social implications for NT, whose responsibility extends beyond its gates to the community. NT should see that its effect on its employees results in changes for the better, where employees themselves decrease the costs that they impose upon the environment.

Step 2B. Identify cost and ownership of cost.

Q. Looking at the list of costs under item 2 in the framework, the decision-maker asks the questions:

(1) of all the possible costs, which one(s) would be relevant if this option is followed?

(2) regarding the ownership of the cost(s), if this option is followed, will the relevant cost(s) be incurred by WNC or passed on to outside parties? That is, which costs do we as a firm capture (internalize)?

(1) - Are penalties, fines, or performance orders possible if this procedure is not developed and established? Yes, refer to contingency decision tree and risk factor determination analysis below.

- Are hazardous materials handling costs going to increase to increase if this option is followed? Perhaps, as these costs are continually increasing for us. The implementation of this procedure would likely decrease them.
- Are there any opportunity costs of not undertaking the development and establishment of this procedure? Yes, since WNC wishes to eventually conform to the EMS standard it will have to improve the way it handles materials. To do it now is cheaper than doing it in the future, so the incremental cost of future development must be considered.
- Will there be lost access to capital or customers if this procedure is not developed? Probably not, as materials transportation procedures are not presently under the scrutiny of lenders, insurers or customers. However, if an accident occurs or WNC is audited now for ISO 14000 compliance, lenders, insurers, suppliers and customers would be alienated to some degree.

(2) - If this procedure is not developed and implemented, there will be some costs that we will be externalizing. First is the cost imposed upon the environment by suppliers as a result of their WNC-specific operations not being conducted

according to optimal procedures. For instance, air emissions from lead smelters could be increasing regional mortality. Second are the costs imposed upon the environment by employees as a result of their lack of awareness of the effects of the improper handling of potentially hazardous materials. The result of this is a loss of bio-diversity and a loss of aesthetic resources, for e.g., excessively large and polluted landfills.

Step 3B. Decide on how to handle costs.

Q. The relevant costs may be of an on-going or a one-time nature. If they are of an on-going nature, the decision to incur these costs will be made within an operational decision-making framework. If they are of a one-time nature, the decision to incur these costs will be made within a strategic decision-making framework.
The relevant model to be applied in the case of operational decisions is activity-based costing. In the case of strategic decisions, the relevant model to be applied is strategic costing, with its primary analysis procedures of capital budgeting.
Thus, the question the decision-maker asks here is: are the costs of an on-going or a one-time nature?

A. Of the costs identified above as costs which would result from not developing this procedure, some should be dealt with under strategic cost management, others under operational cost management. For instance, penalties, fines, and performance orders, all possibilities if this procedure is not developed, will be one-time costs. Similarly, it is worthwhile to evaluate the additional cost of future development and implementation of this procedure within the strategic framework. On the other hand, some on-going costs will be incurred if this option is not pursued. Hazardous materials handling, for instance, can be seen to increase with this option. Therefore, these costs should be incorporated into the activity-based costing system.

Also, some costs may be easily quantified and put into monetary terms; others not. Often, with some effort, they can at least be estimated. So to account for costs, the decision-maker asks the question: is the cost quantifiable? If so, then it can treated under either the financial analysis technique of capital budgeting or the cost accounting technique of activity-based costing, If not, the cost can be assigned a verbal or narrative descriptor.

A. Of all the costs identified above as costs which result from not developing this procedure and which would be captured by WNC, none can be quantified with a high

degree of accuracy at this time. Further, of the costs that can be estimated and will be captured—penalties, fines, and the cost of failing to be ISO 14000 certified—none are likely to find their way directly into WNC financial accounts, given the present manner of accounting at WNC. Therefore, verbal descriptors should accompany the non-quantifiable items if a summary report is prepared.

- Contingency Decision Tree and Risk Factor Determination -

If the 'materials handling: procurement, storage, and transportation procedure' is not developed, penalties or fines may have to be paid by WNC. The question that must be answered is: what is the value of these penalties and fines? A certain amount of data is needed to estimate this amount. First, what are some of the possible penalties and fines that could result from the improper handling of materials? To determine this one looks to legislation which concerns itself with materials handling. This includes such federal and provincial legislation as the Controlled Products Act and the Transportation of Dangerous Goods Act. Also one might look to the case law to make this determination. Corporate counsel should be able to list the titles of the publications dealing specifically with environmentally- and business-related court decisions in the jurisdiction.

Secondly, information regarding the effectiveness of enforcement in the jurisdiction is needed. Enforcement records can be provided by municipal, provincial, and federal environmental law-enforcement agencies.

Lastly, information is needed on the degree of severity of the penalty that might be handed down to WNC. Most of this information is borne from an understanding of the operation, and can thus only be provided by individuals at senior levels who have been employed for long periods.

Suppose, the following information has been gathered by the person wishing to estimate the penalty or fine.

1. The only relevant regulation with which we are concerned is the Controlled Products Act, a contravention of which in this case may result in a corporate fine of $1000.

2. The agency responsible for enforcing this act has been watching the operation somewhat closely, but not to the point where a breach of compliance will automatically result in a charge being laid.

3. The potential for harm and damage from contravention of the act is high; the company is large and wealthy; and the chances of the employee responsible for the offense being dismissed are almost non-existent.

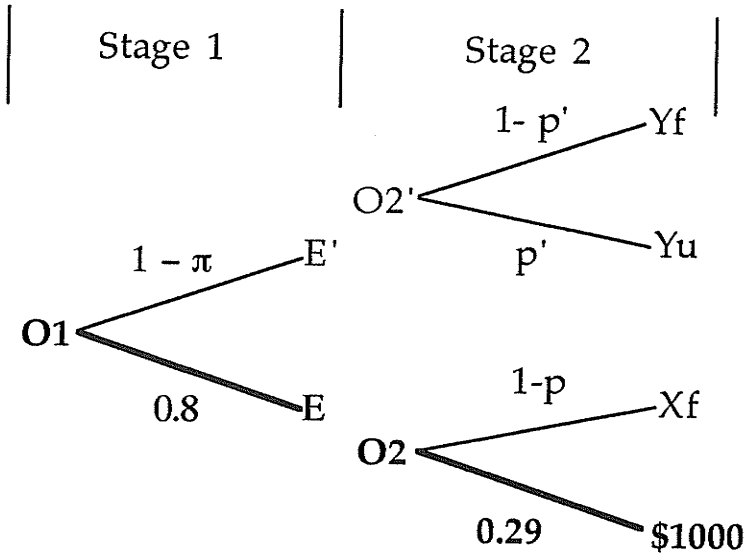
Given this information one now turns to the contingency decision tree and the risk factor determination models. First, the information provided from 3 above is put into the risk factor determination model.

Risk Factor Determination

Weight (Sum = 16/16)	Rating (0.0; 0.33; or 0.66)	Base Variables
0.062	0.66	High actual or potential damage
0.062	0.00	Intent
0.062	0.33	Savings or gain derived from offence
0.062	0.00	Severe intent
0.062	0.66	Ability to pay
0.062	0.66	Large size/wealth of corporation
0.062	0.00	Unfavourable corporate character
0.062	0.33	No plea of guilty
0.062	0.00	Low cooperation/expenditures
0.062	0.33	No laxity of government agencies
0.062	0.33	High reasonableness of standards
0.062	0.00	Prior convictions
0.062	0.00	Tax benefits to fine
0.062	0.66	No dismissal of employees responsible
0.062	0.33	Ease or difficulty of prevention
0.062	0.33	Low social utility of enterprise

Risk Factor 'p'= Σ (Weight x Rating) = 0.294

Completing the table and calculating the figure gives a risk factor of 0.29.[8] This, along with the information provided in 1 and 2 above, is then put into the contingency decision tree model.



By working backward in the decision tree; outcome 2, the cost of being sentenced, becomes $290, and outcome 1, the cost of being sentenced and charged, becomes $232 (the product of 'vigilant' enforcement, 0.8 (estimate), and the sentencing outcome, $290). Therefore, in this example, the estimated cost of contravening the above act as a result of the failure to develop the 'materials handling: procurement, storage, and transportation procedure' is $232.

4.2 The EPC Framework: Results and Discussion

This section elaborates on the exercise just carried out. It begins by first answering the question: does the application of the EPC framework provide better and more insightful information? The section then moves to a discussion of the strengths and weaknesses of the framework, and some limitations on its use.

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[8] It would be preferrable to calculate a range of figures for 'p', using low and high estimates. Often the range provides as much meaning as the mean value, since a wider range suggests greater uncertainty than a narrower one. However, this was not done here for simplicity's sake.

4.2.1 The EPC Framework: Results

At first glance, the choice of whether or not to develop and implement a given procedure required for compliance under the ISO EMS standard appears to involve a tradeoff between the costs of the labour involved, and the benefits accruing to WNC of complying to the standard. Since the ISO EMS standard has not been formally completed, it is not surprising that WNC is having difficulty justifying the allocation of scarce resources for such efforts. It may seem that the decision involves only a cash outlay. The question is: will the EPC framework change WNC decision-makers' views regarding the need to make this allocation? The answer is yes—if the information which the framework provides is used.

Using the EPC framework to analyze this simple go/no-go decision does result in a very different picture of the costs involved in this decision. The framework helps to identify a number of not only hidden costs, but also a number of vectors for which costs are imposed by the WNC operation. In this respect, the framework can be said to be successful.

Undoubtedly, where the framework's utility will come into question regards its raising and subsequent treatment of costs that are typically not captured (internalized) by the firm and costs that can not be quantified accurately, if they can be quantified at all. Yet, it is precisely in raising the profile of such costs that the framework garners merit. The EPC framework may not provide a 'black box' for the proper handling and quantification of environmental costs, but it does at least allow the firm to consider them and hopefully systematically address them.

4.2.2 The EPC Framework: Discussion

At the outset of the research, the client firm expressed interest in not only seeing the development of an EP cost decision-making tool, but also in seeing that tool in action. In order to do this a practical problem had to be chosen. This led to the analysis of the decision of whether or not WNC should develop and implement a single, formal procedure needed to fulfill the requirements of an ISO-compliant EMS. The exercise carried out lends insight into the use of the EPC framework.

However, a full understanding of the usefulness of the framework can only be gained through its extensive use in a number of different situations. For instance, this exercise could have been carried out on WNC's decision to move from air-based to nitrogen-based atmospheres in existing wave solder units. The capital budgeting exercise that was carried out for that process change failed to account for such things as decreased lead handling, the added costs

associated with nitrogen tank maintenance, and the enhanced image that was gained by reducing lead use (see Appendix 6).

It would also be worthwhile to carry out an analysis of a situation involving predominantly on-going costs. Activity-based costing would provide the framework for such an analysis and, as such, it is worthwhile to refer to the work of Brooks *et al.* (1993) for assistance.

What then are some of the strengths of this framework as revealed by the EMS exercise? The most obvious strength of the framework is its role in stimulating awareness of environmentally-related manufacturing and administrative costs. Merely having the EPC framework diagram on-hand during cost or investment analyses should result in at the very least the consideration of these costs. If required, it will also allow for the partial observance of the temporal relationship in manufacturing: environmental effects are imposed at the beginning of the product's life-cycle, via suppliers; right to the end, via the products sold to consumers. The costs themselves are arranged in a temporal fashion, as they are often encountered, i.e., training first, waste last.

A less obvious strength is the framework's dual consideration of environmental costs. There are those that are listed under 'types of cost' and those that are termed 'cost vectors'. The two analyses are somewhat different, the former being detailed, and the latter more conceptual. The idea being that the 'cost vector' list is more holistic and strategic, and the 'types of cost' list is more 'tangible'.

The framework is not without its limitations. First, and foremost, the EPC framework is not a 'black box'. It does not generate numbers nor give definitive information. It simply helps to provide information, although it has no bearing on how that information is used. To be of value, the EPC framework must also be accompanied by management commitment, guided by an appropriate corporate policy, and accepted within the corporate culture.

Another limitation is that there are no 'benefits' shown. This is because benefits are subsumed under opportunity costs, such as lost access to capital, lost customers, and lost tax deductions. For some individuals this may be a troublesome point, especially if they are accustomed to conducting cost/benefit analyses. However, there is justification for treating benefits as 'negative' costs, as it simplifies the framework substantially. If the category of benefits were introduced, the framework would have to be run through twice, once to determine costs and once to determine benefits. So it is better to treat benefits as 'negative'-costs; one need only keep in mind that a benefit of carrying out one option is most likely a cost of carrying out another.

Yet another limitation of the framework as it stands is the fact that some costs are both one-time and on-going, such as opportunity costs, consulting fees, and perhaps inspections and audits. As well, the decision to incur one-time costs may result in the need to incur additional, on-going costs.

Since the contingency decision tree and the risk factor determination models are designed to support the EPC framework, it is also necessary to discuss their strengths and weaknesses. As was seen in the application of the framework, assigning numbers to the effectiveness of enforcement, the sentencing risk factor, and fines and penalties themselves is highly subjective. The best that one can really do is estimate a range for these figures. Indeed, having to 'guess' at these figures is a weakness in the application of the model. However, there is less subjectivity involved in 'guessing' at a figure than there is in the implicit assumption that the figures are for all intents and purposes equal to zero. Moreover, having to 'guess' at a figure helps achieve what the framework is intended to do: stimulate thinking about the environmental effects of WNC operations. On the one hand, there is the limitation of the production of imprecise results; on the other hand there is the benefit of conducting the exercise.

Chapter 5 - Conclusions and Recommendations

The following chapter consists of a brief summary describing the research contained herein; a conclusion addressing the original purpose, objectives, and needs of the research; and finally recommendations regarding future applications and versions of the framework, and suggestions for further research.

5.0 Summary

This research began by introducing an important issue in business today, the environment—society's awareness of which confers increasing responsibilities on business leaders and company employees. The subject is important enough to warrant the expenditure of large sums of money; however, whether or not this money is being spent in the most cost-effective manner is difficult for managers to determine. This research addressed this problem by synthesizing current management accounting and cost determination concepts and methods, and evaluating them in light of their applicability in dealing with environmental protection costs.

Then, in order to move this research from the 'normative' to the practical realm, a framework for handling environmental protection costs was developed and tailored to the needs of a specific manufacturing operation. This framework was then applied to a practical situation, in order to draw conclusions about its practicality and usefulness. The application of the framework revealed a number of strengths and weaknesses, and raised a number of important questions.

5.1 Conclusion

At the beginning of the research the purpose of the study was laid out, objectives formulated, and a statement of need articulated. The success of this research is predicated on how these three items were subsequently addressed. The following discourse revisits these items and then closes by identifying the limitations that were revealed over the course of the study. Once again these objectives were:

- to evaluate the current methods of cost quantification used in industry,
- to determine which method, or what combination of methods, best enables the client firm to evaluate its on-going and one-time EP costs,
- to develop for future use by the client firm an EP cost evaluation framework based upon the current knowledge of environmental issues as they apply to business and the specific needs of the client firm, and
- to apply the EPC framework to an unresolved problem in the client firm, so as to test the EPC framework's usefulness.

The methods used for management accounting and capital budgeting are similar throughout the industrialized countries and across the industries within these countries. The review of the current work on these methods was thorough, so very little chance exists that a particular, relevant method was missed.

Under WNC's operational and strategic decision orientations, two main methods were chosen for use. These are, respectively, ABC and strategic costing. These are to be supplemented with value-chain analysis—a strategic cost management technique now being implemented at WNC; contingent liability cost estimation; and any defensible qualitative cost estimation, such as loss of market share due to the alienation of environmentally-concerned customers.

Capital budgeting procedures are being used now for making investment decisions, and it is suggested that they continue to be used for handling EP costs in those decisions. The key to determining whether EP costs can be subjected to a net present value analysis depends on how well traditional non-monetized costs can be monetized. Further, the firm's cost of capital is unlikely to be appropriate for use in discounting environmental costs (a maxim in long use by resource economists). For these reasons, it must be accepted that many environmental costs will have to be estimated, and that failure to estimate them simply because one is opposed to 'guessing' is in itself a subjective judgment.

While hardly a rigorous or sophisticated model, the framework provides important information, namely a holistic list of costs and a detailed list. This raises two very important points regarding the use of the EPC framework. First, the model is neither designed to give definitive answers or generate numbers. What it does do is generate awareness and aid in discussion. The EPC framework should thus be regarded as a tool for aid in operational decision-making.

Second, though the framework helps to provide information about costs related to the environment, the information will be of limited use unless it is used strategically. This point takes us back to the earlier discussion of strategic cost management. It is not the information alone which will bring about change, rather it is the way that this information is used. Further, paradigmatic changes in corporate culture may be required before the information brings about changes for the better, both in terms of sustained competitive advantage and improved corporate stewardship.

The framework offers the potential to assist in two areas. First, the framework demonstrates the financial importance of environmental protection by its inclusion of such cost items as waste energy and opportunity costs; items that stimulate the imagination business decision-makers need to address environmental issues in a proactive and aggressive fashion.

Second, the identification of the different entities: vendors, suppliers, employees, products, etc. allows the decision-maker the opportunity to consider hitherto unaddressed areas for improvements. While working at WNC, the researcher noted that in fact it was the vendors who were probably the group who were most neglected during assessments of WNC's environmental effects. No rules, agreements, or even understandings were established regarding the use or disposal of environmentally detrimental substances such as pesticides used for landscaping or products used for cleaning. Granted, common sense likely dictates the actions of this group, but reliance on common sense violates the requirements of environmental due diligence.

Related to the need for this study is the efficacy of the EPC framework in providing the accounting/EMS linkage. It is demonstrated here in two ways. First, the WNC EMS was the subject of experimentation in a study whose theme is corporate accounting. Second, since the day-to-day costs of an EMS are typical of costs that are traditionally allocated to general overhead, and since the whole purpose of activity-based costing is to attach these costs to product and processes, it can be said that this study through its recommendations does indeed provide the accounting/EMS linkage.

Also related to the need for this study is the efficacy of the EPC framework in providing the link between EP cost analysis and environmental risk assessment. Carrying out an analysis of costs on a day-to-day basis and recognizing the environmental and social effects of these costs requires an understanding of the environmental and social effects of WNC activities. Gaining this understanding is not only a prerequisite of the EPC framework, but also a prerequisite of an environmental risk analysis. Therefore in obtaining data for carrying out the

EPC framework evaluation exercise, one is also obtaining data for the environmental risk analysis.

The EPC framework reveals information for decision-making that traditional analysis fails to reveal , but does this mean that the framework necessarily helps the client firm to optimally allocate its resources? The answer is no. This is because analyses can not be conducted on a piece-by-piece basis. All of the operation at all levels must be subject to an evaluation. For example, the approximated $51,000 required for the implementation of the EMS (Appendix 5) might be better spent on product re-development or research into non-lead-containing solder. Of course the suggestion that every project and cost be analyzed is impracticable. The point to be made is that comparisons, not isolated decisions, must be carried out.

A number of other findings were revealed over the course of the study. The first of these is specific to the EPC framework. Because an analysis of the costs involved in developing and implementing the EMS necessitates a thorough understanding of the WNC operation, which the researcher admittedly does not have, many items that could have been included in the evaluation were not. Thus the costs of both moving the 'materials handling: procurement, storage, and transportation' procedure forward or not moving the procedure forward are understated.

There are also other findings which were hinted at in the study. First, this study did not address contaminated-site remediation, a very significant cost in industry and for Northern Telecom. This was because the WNC location—which is relatively new and has rather benign production processes—is not perceived to be contaminating the plant's physical surroundings. However, this cost is worthy of research in its own right. Second, the study did not look at what can be done by Northern Telecom WNC to protect the environment as opposed to what is being done. Again, this topic is worthy of a treatise on its own.

5.2 Recommendations

There are two areas in which recommendations are warranted. First, at WNC in regards to the EPC framework there are three main recommendations. Second, in the general research field, four recommendations follow from this research.

5.2.1 Recommendations Specific to the EPC Framework

The first recommendation specific to the WNC and the EPC framework:

- Since Northern Telecom is considered by many to be a leading firm in many areas, including environmental protection, Wireless Networks Calgary must begin to estimate the costs of environmental protection: whether they be costs in the traditional sense, such as staff salaries or audits; or non-traditional albeit significant costs, such as the costs of foregone revenue or contingent liabilities.

The second recommendation specific to the WNC and the EPC framework:

- The EPC framework works and for this reason WNC should conduct an in-house, pilot study to further develop it. A practical summary for the application of the EPC framework and its attendant models are included for this purpose (see Appendix 7). If WNC proceeds with the framework, some sub-recommendations are in order. These will help facilitate the implementation of the framework's two cost determination components, activity-based costing and capital budgeting:

  For activity-based costing:
  - ensure senior management buy-in
  - structure system so that there is an incentive to participate in the determination and tracking of costs
  - realize that acceptance occurs only gradually
  - ensure that visibility of the issue is high
  - obtain the best possible data with the minimum amount of support

  For capital funds appropriation (capital budgeting):
  - expand the requirements of CFAs to include items beyond those that only appear in the department's budget (for e.g., decreased waste generation)

- establish greater conformity in the requirements of CFAs/poll managers and employees on what the environmental priorities should be
- allow for and support the use of narrative descriptors in CFAs

The third and most important recommendation specific to the WNC and the EPC framework:

- Fit the EPC framework into WNC's overall strategy. This would force WNC management to ask and begin to answer the question: "how much social cost do we want to internalize?" Further, by doing this, needed awareness at the operational level regarding the environmental effects of the WNC operation would be induced.

5.2.2 Future Research

This research raised a number of issues, some of which are worthy of future research. In particular, there are five questions that should be answered so as to move forward the issues which this study addresses:

1. How would the results of this study differ if it were carried out at another NT location? In another company? Or in another industry?
2. What are the implications for the areas of WNC's business that are tied to ISO compliance if the company chooses ABC in lieu of a quality costing system (for e.g., the quality system? the EMS? etc.)?
3. In dealing with the environmental costs associated with NT, some important costs are seen to be very difficult to estimate. Chief among these are opportunity costs. Research into the methods of estimation of these costs is needed.
4. What is the nature of NT's environmental strategy? How are objectives set and what drives them? This might answer the question of why WNC, not the parent NT, is charged with the responsibility of determining resource allocation for environmental protection.
5. The broadest question and the most evasive one worth asking is: when do environmental externalities become contingencies? That is, when do companies mandatorily have to assume the responsibility for dealing with their environmental costs?

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APPENDICES

WIRELESS SYSTEMS CALGARY

Northern Telecom employs approximately 700 people at its Calgary-based facility in the manufacture of sophisticated Digital and Analog radios and supporting systems, used by telecommunications companies in many countries around the world. In addition WSC is recognized as the development center of Personal Communications Services (Companion).

The 37,000 square-meter (120,000 square-foot) facility, which opened in 1975 in Calgary's Skyline Industrial Park, represents a more than $40 million investment by Northern Telecom in high-technology development in Alberta. The facility was initially built to manufacture Digital Switching (DMS) Equipment, making a transition to Wireless Systems in 1991.

Our facility has been recognized as a leader in Total Quality Manufacturing, Self Management Work Teams, and Commitment to Excellence! (a Northern Telecom initiative).

The facility manufactures technology-rich Digital and Analog Radio Units in addition to systems that support the radios. The digital radios feature a high level of security, and three voice channels vs. the standard one (potential to have 10 channels/conversations within the same bandwidth) The analog radios offer a low cost alternative in the competitive RF market.

The actual manufacturing process at the location is as sophisticated as the communication systems themselves. To manufacture circuit boards that are part of any of the products, a staged process was engineered. This process includes a cycle time of five days, component placement rates of 9000/hr, and extensive testing facilities. Future technological manufacturing developments range from double sided reflow soldering, to nitrogen atmosphere soldering and automatic vision inspection.

Northern Telecom is the leading global supplier of fully digital telecommunications switching systems, providing products and services to telephone operating companies, corporations, governments, universities and other institutions worldwide. Northern Telecom, with 1992 revenues of US$8.18 billion, employs over 57,000 people worldwide.

(Note: Wireless Systems Calgary became Wireless Networks Calgary in the spring of 1995.)

- Appendix 2 -

Northern Telecom - Wireless Networks Calgary
List of Relevant Environmental Regulations
(at June 1994)

General Regulations

Northern Telecom's Environmental Policy (at 1994)

Northern Telecom's Corporate Standard 180.50, Sections 4.5 and 4.6

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.)

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3

Criminal Code R.S.C. 1970 c.C-34

Civil Remedies Available at Common Law

National Pollutants Release Inventory

Government Organizations Act 1979: Environmental Assessment and Review Policy Guidelines Order SOR /84-467

Environmental Assessment and Enhancement Act S.A. 1992 c.E-13.3: Division 1 - Environmental Assessment Process

Environmental Assessment and Enhancement Act S.A. 1992 c.E-13.3: Environmental Protection and Enhancement (Miscellaneous) Regulation, Alta. Reg. 118/93

Environmental Assessment and Enhancement Act S.A. 1992 c.E-13.3: Environmental Assessment (Mandatory and Exempted Activities) Regulation, Alta. Reg. 111/93

Environmental Assessment and Enhancement Act S.A. 1992 c.E-13.3: Environmental Assessment Regulation, Alta. Reg. 112/93

Environmental Assessment and Enhancement Act S.A. 1992 c.E-13.3: Activities Designation Regulation, Alta. Reg. 110/93

City of Calgary Land Use Designation: Section 45, S.S.1-2, General Light Industrial District

Regulations Governing Air Emissions

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Ambient Air Quality Objectives (P.C. 1989-1482)

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.) Environmental Code of Practice for the Reduction of CFC Emissions from Refrigeration and Air-Conditioning Systems, March 1991

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Ozone-depleting Substances Regulations, No. 4, SOR/93-214

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Secondary Lead Smelter Release Regulations, SOR/91-155

Motor Vehicle Safety Act: Motor Vehicle Safety Regulations, c.R.C. 1978, c.1038

IEEE C95.1, 1991 Standard for Exposure to Radio-Frequency and Microwave Radiation

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Air Emissions Regulation, Alta. Reg. 124/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Alberta Ambient Air Quality Guidelines

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Approvals Procedure Regulation, Alta. Reg. 113/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Part 4 - Release of Substances

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Release Reporting Regulation, Alta. Reg. 117/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Ozone-Depleting Substances Regulation, Alta. Reg. 125/93

Public Health Act S.A. 1984, c.P-27.1

Public Health Act S.A. 1984, c.P-27.1: Nuisance and General Sanitation Regulation, Alta. Reg. 242/85

Calgary By-law #9025, Nuisances and Untidy and Unsightly Premises

Regulations Governing Liquid Effluent

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products, March 1993

Fisheries Act, R.S.C. 1985, c.F-14

Fisheries Act, R.S.C. 1985, c.F-14: A Code of Good House-Keeping Practice for the Metal-Finishing Industry, November 1977

Fisheries Act, R.S.C. 1985, c.F-14: Metal-Finishing Industry Liquid Effluent Guidelines

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Par 4 - Release of Substances

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Release Reporting Regulation, Alta. Reg. 117/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Part 7 - Potable Water

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Approvals Procedure Regulation, Alta. Reg. 113/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Industrial Plants Regulation, Alta. Reg. 121/93

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Wastewater and Storm Drainage Regulation, Alta. Reg. 119/93

Calgary By-law #56M84, Sewer Service

Regulations Governing Materials Handling

International Air Transportation Association, Resolution 618, Attachment "A": Dangerous Goods Regulations, 1994

Canadian Electrical Code (16th Edition)

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products, March 1993

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Storage of PCB Material Regulations SOR/92-507

Hazardous Products Act R.S.C. 1985, c.H-3

Hazardous Products Act R.S.C. 1985, c.H-3: Controlled Products Regulations SOR/88-66

Pest Control Products Act R.S.C. 1985, c.P-9

Pest Control Products Act R.S.C. 1985, c.P-9: Pest Control Products Regulations C.R.C. 1978 c.1253

Transportation of Dangerous Goods Act S.C. 1992 c.34

Transportation of Dangerous Goods Act S.C. 1992 c.34: Transportation of Dangerous Goods Regulations SOR/85-77

Transportation of Dangerous Goods Control Act S.A. 1982, c.T-65

Transportation of Dangerous Goods Control Act S.A. 1982, c.T-65: Transportation of Dangerous Goods Control Act Regulations, Alta. Reg. 383/85

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Part 8 - Hazardous Substances and Pesticides

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Pesticide Sales, Handling, Use and Application Regulation, Alta. Reg. 126/93

Fire Prevention Act: Alberta Fire Code 1992, Alta. Reg. 204/92

Calgary By-law #67M87, Transportation of Dangerous Goods

Regulations Governing Waste

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Exports and Imports of Hazardous Wastes, SOR/92-637

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Toxic Substances Export Notification Regulations, SOR 92-634

Canadian Environmental Protection Act R.S.C. 1985 c.16 (4th Supp.): Hazardous Waste Incineration Facilities Guidelines, March 1992

Environmental Contaminants Act R.S.C. 1985,c.E-12: Guidelines for the Management of Biomedical Waste in Canada

Environmental Contaminants Act R.S.C. 1985,c.E-12: Guidelines for the Management of PCB Wastes, December 1982

Transportation of Dangerous Goods Act S.C. 1992 c.34: Transportation of Dangerous Goods Regulations SOR/85-77

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Part 9 - Waste Minimization, Recycling and Waste Management

Environmental Protection and Enhancement Act S.A. 1992 c.E-13.3: Waste Control Regulation, Alta. Reg. 129/93

Clean Water Act S.A. 1992, E-13.3: Industrial Landfill Guidelines, June 1987

Public Health Act S.A. 1984, c.P-27.1: Nuisance and General Sanitation Regulation, Alta. Reg. 242-85

Public Health Act S.A. 1984, c.P-27.1: Waste Management Regulation, Alta. Reg. 250-85

Public Lands Act R.S.A. 1980, c.P-30

Calgary By-law #13M82, Garbage, Refuse and Waste

Calgary By-law #39M93, Unsightly Premises

City of Calgary Land Use Designation: Section 45, S.S.1-2, General Light Industrial District

- Appendix 3 -

Handout for Interviews

Research into Methods of Accounting for Environmental Protection Costs

Purpose:

the purpose of this research is to help Northern Telecom find a better way to measure and control its costs of environmental protection.

Objectives:

- to examine the applicability of quality costing methods; activity based costing methods; and contingent liability costing methods for use in accounting for environmental protection costs
- to evaluate the above methods using an actual case(s) and input from those persons directly involved in the gathering and use of the information
- to describe existing Northern Telecom, Wireless Systems Calgary's environmental protection cost accounting methods

Methods:

- review literature related to cost accounting, environmental law and total quality management
- discuss and explore appropriateness and applicability of quality costing, activity based costing, and contingent liability accounting methods with relevant NT WSC individuals
- discuss existing NT WSC environmental protection cost accounting methods with relevant NT WSC individuals

Northern Telecom's Potential Benefits of Environmental Protection

- Savings on materials, energy, waste disposal, and time devoted to dealing with environmental problems
- Improved access to debt and equity capital and insurance coverage
- Better public and employee relations
- Greater flexibility in dealing with regulations and ability to influence industry and regulatory standards

Northern Telecom's Potential Costs of Environmental Protection

There are three broad categories of costs:

1. Preparation:
    - technological modification to control, neutralize, recycle, or dispose of the output of processes
    - changing source materials
    - obtaining permits
2. Maintenance:
    - general administration (e.g., maintaining environmental management system)
    - waste disposal and handling costs
    - recycling and reuse costs
    - staff training
    - environmental auditing costs
3. Reparation:
    - fines and penalties
    - performance requirements
    - litigation costs
    - re-acquiring alienated customers
    - sub-optimal use of production inputs
    - excess production of waste

Activity Based Costing

Attaches costs to appropriate products, processes, or customers

Allows for detailed cost and non-cost information

Two steps: (1) identify costs and (2) assign costs via 'cost drivers'.

Two types of cost drivers:

(1) resource drivers - assign cost of resources to activities

(2) activity drivers - assign cost of activities to products, processes or customers

Two types of activities:

(1) micro activities - detailed cost and non-cost information

(2) macro activities - grouping of micro activities for overall costing decisions

Micro grouped into macro according to three criteria:

(1) same level of activity?

(2) same activity driver?

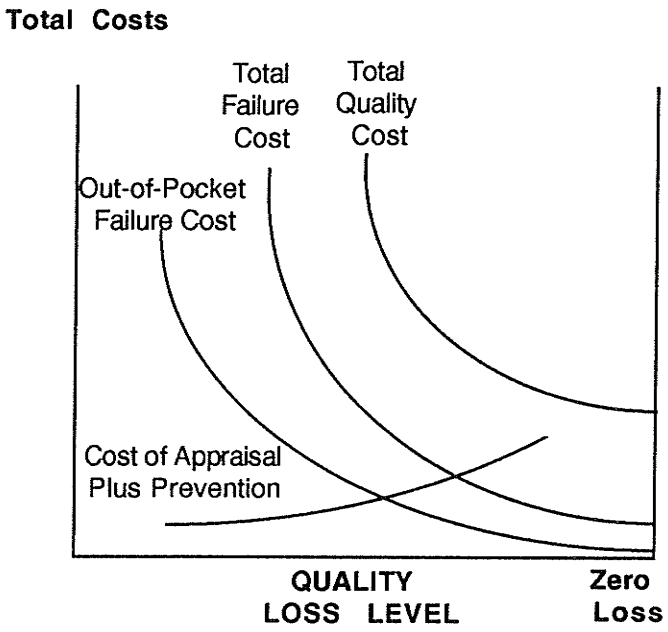
(3) activities have same purpose or function?

Examples of cost drivers related to environmental protection:

- # of recyclable and reusable products, quantity of the products, strength of resale market
- environmental legislation
- # of facilities audited and extent and frequency of audit
- extent of training programs
- # of organizational changes required
- # of response alternatives and extent of environmental risk involved

Quality Costing (Return on Quality)

Model of Quality Costs



(Carr and Tyson 1992)

Failure Costs

External - fines, penalties, etc.

Internal - inefficient use of energy, etc.

Appraisal Costs

Environmental audits, etc.

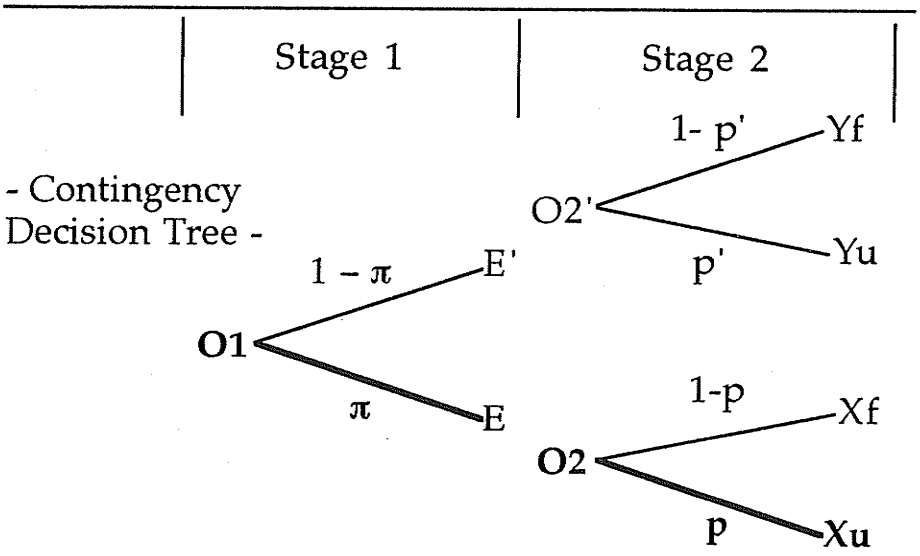
Prevention Costs

Technology and staff training

Contingent Liability Costs

Contingent liabilities are the 'hidden' costs associated with a company's failure to adequately protect the environment. These are such things as the penalties resulting from the commission of quasi-criminal offenses, performance requirements stemming from contaminated site responsibilities, and the 'contingencies of change' (failure to take the future into account).

One possible way of estimating the monetary costs associated with contingent liabilities is through the use of the contingency decision tree, based on the model of expected value.



For each out-of-compliance situation a separate contingency decision tree is drawn. A value for π is then derived by arbitrarily determining the level of enforcement in the jurisdiction: π is equal to 1.0 if there is 100 percent enforcement and 0.0 if there is no enforcement.[1] This is how the probability of being charged, π, is determined.

The next step is more complicated. The penalty range must be determined and a probability for each level of penalty given. The highest penalty will likely be dealt out only in the most "egregious of circumstances." Egregious circumstances, it will be suggested, are achieved when all sixteen of Swaigen and Bunt's sentencing factors (1985) are realized. Therefore, one can estimate the exposure to monetary penalty by estimating the likelihood of the enactment of these factors. A decision tree with these factors is provided in the Decision Variable Worksheet.

Since this framework is only a rule of thumb and not intended to supply complete information to the decision-maker, it is not appropriate to use an elaborate numbering scheme

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[1] Unfortunately setting $\pi = 1$ because of a moral obligation reduces the validity of the model.

for determining the probabilities of the enactment of the sentencing factors. For this reason only three ratings will be used: likely, not likely, and not determinable.[2] A 'not determinable' rating carries a factor of zero; a 'not likely' rating carries a factor of .33; and a 'likely' factor a rating of .66. These ratings correspond to the probability range expressions appearing in the CICA *Handbook* Section 3290.06.

Having completed the decision variable worksheet, the assessor or decision-maker now has a decision variable which is equivalent to the probability "p" shown above. This probability "p" is now multiplied by the predetermined maximum penalty "Xu" and this gives an expected outcome "O2." Finally, π is multiplied by the expected outcome "O2" to give "O1." "O1" is the contingent liability cost for that regulatory issue.

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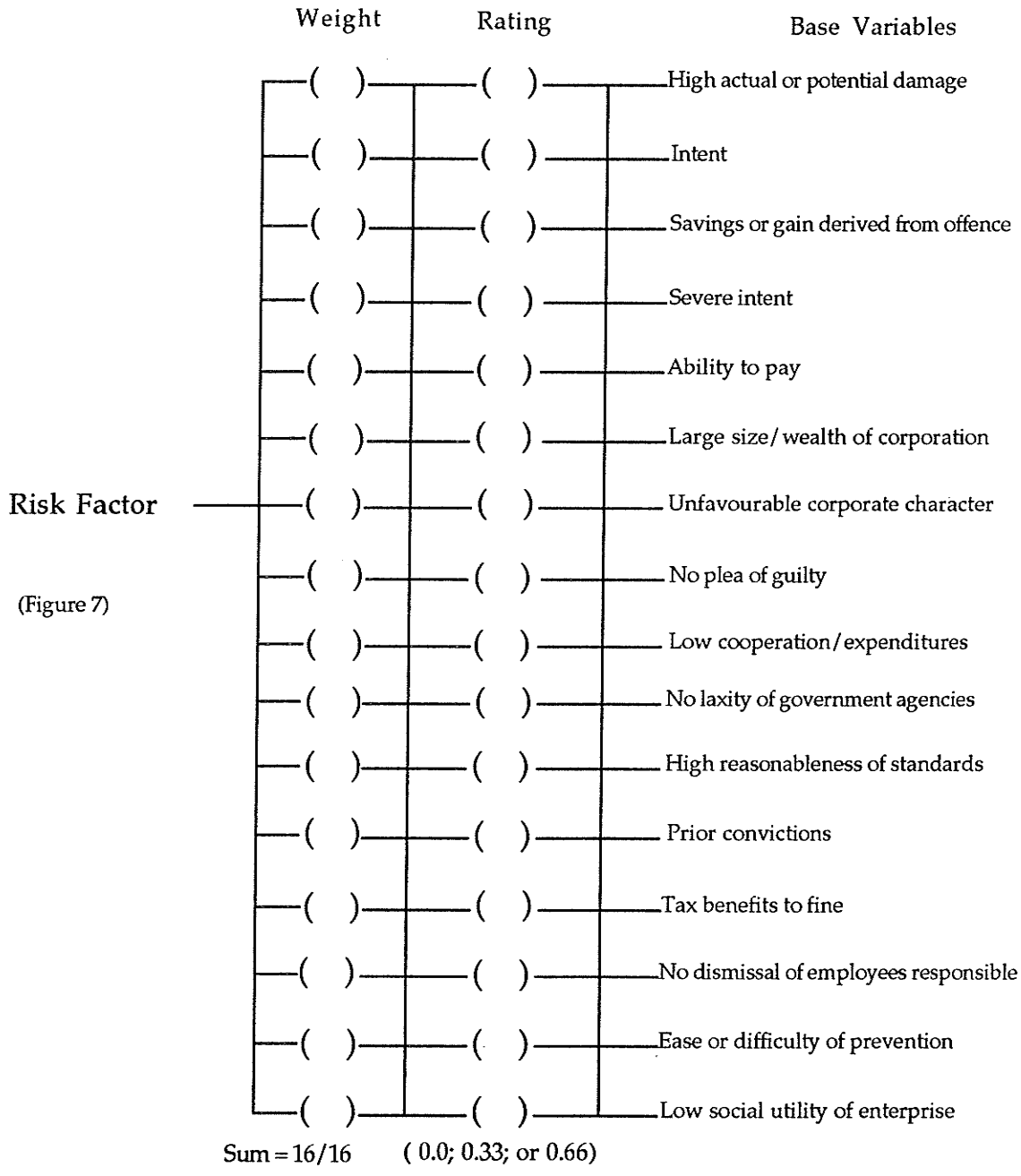
[2] Ideally we would like to turn to the American jurisdiction where there is more experience and interest in dealing with uncertainty. Indeed, it would be better to use the American rating system as it does not mix likelihood with precision as does the Canadian system. There, 'probable', 'reasonably possible', and 'remote', define the range of uncertainty (Mock and Vertinsky, 1985). However, in the interest of convention this was not done.

Risk Factor Determination



(Figure 7)

(Adapted from Swaigen and Bunt 1985)

Specification

Introduction

Organizations of all kinds are increasingly concerned to achieve and demonstrate sound environmental performance. They do so in the context of increasingly stringent legislation, the development of economic and other measures to foster environmental protection, and a general growth of concern about environmental matters.

Many organizations have undertaken environmental 'reviews' or 'audits' to assess their environmental performance. On their own, however, reviews and audits cannot provide an organization with the assurance that its performance not only meets, but will continue to meet, legislative and policy requirements. To be effective, they need to be conducted within a structured management system, integrated with overall management activity and addressing significant environmental effects.

This British Standard specifies the elements of such an environmental management system, intended to apply to all types and sizes of organization. The basis of the approach is shown in flow chart form in figure 1. It should be noted that many of the stages may be addressed concurrently or revisited at any time. The success of the system depends on commitment from all levels, especially from the highest levels of management. A system of this kind enables an organization to establish, and assess the effectiveness of, procedures to set an environmental policy and objectives, achieve compliance with them, and demonstrate such compliance to others. The standard is also intended to support certification schemes.

NOTE. Elements within the box shown in double lines in figure 1 are part of the specification and are therefore assessable elements in a system.

In addition to specifying the requirements for an environmental management system, the standard also provides guidance, in annex A, on implementation and assessment. For ease of use, the principal subclauses of the specification and guide have related numbers; thus, for example, **4.5** and **A.5** both deal with environmental objectives and targets, and **4.10** and **A.10** both deal with environmental management audits.

NOTE. The preparatory review is included in the guide (see A.1.2), but is not part of the specification, because it is not an assessable element of an established system. However, it is likely to be valuable to any organization without a formal environmental management system in place which wishes to apply this standard, because it will help ensure that subsequent efforts are optimally effective.

Environmental management audits and environmental management reviews are inherent, but separate, parts of the system. Audits assess both the effectiveness of the environmental management system and the achievement of the environmental objectives. Reviews check the continuing relevance of the environmental policy, update the evaluation of environmental effects, and check the efficacy of audits and follow-up actions.

This British Standard is compatible with BS 5750, as they take parallel approaches to achieving and demonstrating compliance with specified requirements. Annex B explains the links between them. It is expected that organizations operating to BS 5750 will readily be able to extend their management systems in accordance with this standard, but operation to BS 5750 is not a prerequisite for operation to this standard.

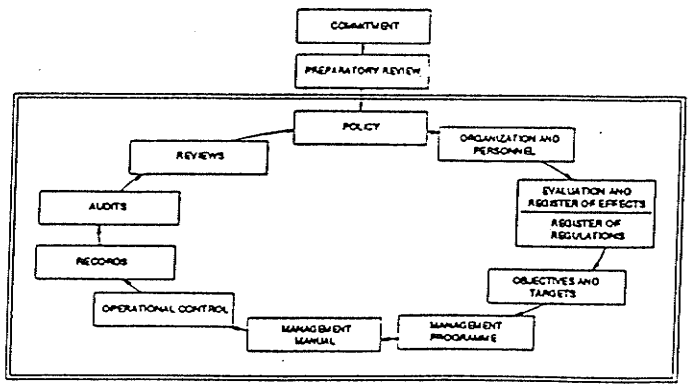


Figure 1. Schematic diagram of the stages in the implementation of an environmental management system

1 Scope

This British Standard specifies requirements for the development, implementation and maintenance of environmental management systems aimed at ensuring compliance with stated environmental policy and objectives. The standard does not itself state specific environmental performance criteria, but requires organizations to formulate policies and objectives taking into account information about significant environmental effects.

The standard is applicable to any organization that wishes to:

a) assure itself of its compliance with a stated environmental policy; and

b) demonstrate such compliance to others.

All the elements specified in the standard are intended to be incorporated into any environmental management system, but the extent of the application of any one element will depend on such factors as the environmental policy of the organization, the nature of its activities and the conditions in which it operates.

2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard the following definitions apply.

3.1 continual improvement

Year-on-year enhancement of overall environmental performance, not necessarily in all areas of activity, resulting from continuous efforts to improve in line with environmental policy. This enhancement will, where appropriate, be achieved by measures such as:

a) developments in products, services, processes and facilities;

b) enhanced product quality, operational efficiency and resource utilization;

c) the application of measures, with a view to reducing adverse environmental effects to levels not exceeding those corresponding to economically viable application of best available technology (see A.5).

3.2 environment

The surroundings and conditions in which an organization operates, including living systems (human and other) therein. As the environmental effects (see 3.3) of the organization may reach all parts of the world, the environment in this context extends from within the workplace to the global system.

3.3 environmental effect

Any direct or indirect impingement of the activities, products and services of the organization upon the environment, whether adverse or beneficial.

3.4 environmental effects evaluation

A documented evaluation of the environmental significance of the effects of the organization's activities, products and services (existing and planned).

3.5 environmental effects register

A list of the significant environmental effects, known or suspected, of the activities, products and services of the organization.

3.6 environmental management

Those aspects of the overall management function (including planning) that develop, implement and maintain the environmental policy.

3.7 environmental management audit

A systematic evaluation to determine whether or not the environmental management system and the environmental performance it achieves conform to planned arrangements, and whether or not the system is implemented effectively, and is suitable to fulfil the organization's environmental policy and objectives.

3.8 environmental management manual

The documentation describing the overall system, and making reference to the procedures for implementing the organization's environmental management programme.

3.9 environmental management programme

A description of the means of achieving environmental objectives and targets.

3.10 environmental management review

The formal evaluation by management of the status and adequacy of the organization's environmental policy, systems and procedures in relation to environmental issues, regulations and changing circumstances.

3.11 environmental management system
The organizational structure, responsibilities, practices, procedures, processes and resources for implementing environmental management.

3.12 environmental objectives
The broad goals, arising from the environmental policy and effects evaluation, that an organization sets itself to achieve, and which are quantified wherever practicable.

3.13 environmental policy
A public statement of the intentions and principles of action of the organization regarding its environmental effects, giving rise to its objectives and targets.

3.14 environmental targets
Detailed performance requirements, quantified wherever practicable, applicable to the organization or parts thereof, that arise from the environmental objectives and that need to be set and met in order to achieve those objectives.

3.15 interested parties
Those with an interest in the environmental effects of an organization's activities, products and services. They include those exercising statutory environmental control over the organization, local residents, the organization's workforce, investors, and insurers, customers and consumers, environmental interest groups and the general public.

3.16 organization
Any organized body or establishment, for example, a business, company, government department, charity or society. For bodies or establishments with more than one site, a single site may be defined as an organization.

3.17 verification activities
All inspection, test and monitoring work related to environmental management.

4 Environmental management system requirements

4.1 Environmental management system
The organization shall establish and maintain an environmental management system as a means of ensuring that the effects of the activities, products and services of the organization conform to its environmental policy and associated objectives and targets. This shall include:

a) the preparation of documented system procedures and instructions in accordance with the requirements of this standard;

b) the effective implementation of the system procedures and instructions.

In implementing the environmental management system, the organization shall take account of any pertinent code of practice to which it subscribes.

4.2 Environmental policy
The organization's management shall define and document its environmental policy, within the context of the environmental policy of any broader corporate body of which it is a part and with the endorsement of that body (see 3.16). The management shall ensure that this policy:

a) is relevant to its activities, products and services, and their environmental effects;

b) is communicated, implemented and maintained at all levels in the organization;

c) is made publicly available;

d) includes a commitment to continual improvement of environmental performance;

e) provides for the setting and publication of environmental objectives;

f) states which of the organization's activities are covered by the particular environmental management system;

g) indicates how the environmental objectives will be made publicly available.

4.3 Organization and personnel

4.3.1 ***Responsibility, authority and resources***
The organization shall define and document the responsibility, authority and interrelations of key personnel who manage, perform and verify activities having a significant effect, actual or potential, on the environment, including those who need the organizational freedom and authority to:

a) provide sufficient resources and personnel for implementation;

b) initiate action to ensure compliance with environmental policy;

c) identify and record any environmental problems;

d) initiate, recommend or provide solutions to those problems through designated channels;

e) verify the implementation of such solutions;

f) control further activities until any environmental deficiency or unsatisfactory condition has been corrected;

g) act in emergency situations.

4.3.2 ***Verification resources and personnel***
The organization shall identify in-house verification requirements and procedures, provide adequate resources and assign competent personnel for verification activities (see also 4.3.4).

4.3.3 ***Management representative***
The organization shall appoint a management representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of this standard are implemented and maintained.

4.3.4 *Personnel, communication and training*

The organization shall establish and maintain procedures to ensure that its employees or members, at all levels, are aware of:

a) the importance of compliance with the environmental policy and objectives, and with the requirements of this standard;

b) the significant environmental effects, actual or potential, of their work activities and the environmental benefits of improved performance;

c) their roles and responsibilities in achieving compliance with the environmental policy and objectives, and with the requirements of this standard;

d) the potential consequences of departure from specified operating procedures.

The organization shall establish and maintain procedures for identifying training needs, and for providing appropriate training for all personnel whose work may have a significant effect upon the environment. Records of training shall be maintained (see also 4.9).

Personnel performing specific assigned tasks shall be competent on the basis of appropriate education, training and/or experience, as required by legislation or regulation, if such exists, and by the organization.

4.3.5 *Contractors*

The organization shall establish and maintain procedures to ensure that contractors are made aware of relevant environmental management system requirements and provisions.

4.4 Environmental effects

4.4.1 *Communications*

The organization shall establish and maintain procedures for receiving, documenting and responding to communications (internal and external) from relevant interested parties concerning its environmental effects and management (see also 4.9).

4.4.2 *Environmental effects evaluation and register*

The organization shall establish and maintain procedures for identifying, examining and evaluating the environmental effects, both direct and indirect, of its activities, products and services, and for compiling a register of those identified as significant. The procedures shall include, where appropriate, consideration of:

a) controlled and uncontrolled emissions to atmosphere;

b) controlled and uncontrolled discharges to water;

c) solid and other wastes;

d) contamination of land;

e) use of land, water, fuels and energy, and other natural resources;

f) noise, odour, dust, vibration and visual impact;

g) effects on specific parts of the environment, including ecosystems.

The procedures shall include consideration of effects arising, or likely to arise, as consequences of:

1) normal operating conditions;

2) abnormal operating conditions, including shut-down and start-up conditions;

3) incidents, accidents and potential emergency situations;

4) past activities, current activities and planned activities.

4.4.3 *Register of legislative, regulatory and other policy requirements*

The organization shall establish and maintain procedures to record all legislative, regulatory and other policy requirements and codes (to which the organization subscribes) applicable to the environmental aspects of its activities, products and services.

4.5 Environmental objectives and targets

The organization shall establish and maintain procedures to specify its environmental objectives, and consequent targets, at all relevant levels within the organization.

In addition to compliance with all relevant legislative and regulatory requirements, other objectives and targets shall be identified after consideration of the environmental effects register, the financial, operational and business requirements of the organization, and the views of relevant interested parties.

The objectives and targets shall be consistent with the environmental policy, and shall quantify wherever practicable the commitment to continual improvement in environmental performance over defined time-scales.

4.6 Environmental management programme

The organization shall establish and maintain a programme for achieving the objectives and targets. It shall include:

a) designation of responsibility for achieving targets at each relevant function and level of the organization;

b) the means by which they are to be achieved.

Separate programmes shall be established in respect of the environmental management of projects relating to new developments, products, services or processes, or to modified products, services or processes (where the modification introduces significantly different environmental effects), to define:

1) the environmental objectives to be attained;

2) the mechanisms for their achievement;

3) the procedures for dealing with changes and modifications as projects proceed;

4) the corrective mechanisms that will be employed should the need arise, how they will be activated and how their adequacy will be measured in any particular situation in which they are applied.

NOTE. The phrase 'environmental assessment' is widely used to mean a study required by authorities, under the planning process, for certain types of development.

4.7 Environmental management manual and documentation

4.7.1 *Manual*

The organization shall establish and maintain a manual or manuals, in paper or electronic form, to:

a) collate the environmental policy, objectives and targets, and programme;

b) document the key roles and responsibilities;

c) describe the interactions of system elements;

d) provide direction to related documentation and describe other aspects of the management system, where appropriate.

In addition to dealing with the normal activities of the organization, the manual (or related documentation) shall cover abnormal operating conditions, and incidents, accidents and potential emergency situations. Emergency plans shall, where necessary, contain relevant environmental information and instructions. The emergency plans shall be tested, wherever practicable, by methods capable of checking their suitability and effectiveness.

4.7.2 *Documentation*

The organization shall establish and maintain procedures for controlling all documents required by this standard to ensure that:

a) they can be identified with the appropriate organization, division, function or activity;

b) they are periodically reviewed, revised as necessary and approved for adequacy by authorized personnel prior to issue;

c) the current versions of relevant documents are available at all locations where operations essential to the effective functioning of the system are performed;

d) obsolete documents are promptly removed from all points of issue and points of use.

All documentation shall be legible, dated (with dates of revision), readily indentifiable, maintained in an orderly manner and retained for a specified period. Clear policies and responsibilities shall be established concerning the modification of the various types of document. Their availability within and outside the organization shall be determined.

4.8 Operational control

4.8.1 *General*

Management responsibilities shall be defined to ensure that control, verification, measurement and testing within individual parts of the organization are adequately coordinated and effectively performed.

4.8.2 *Control*

The organization shall identify functions, activities and processes which affect significantly, or have the potential to affect significantly, the environment. The organization shall plan such functions and activities to ensure that they are carried out under controlled conditions. Particular attention shall be paid to the following.

a) Documented procedures and work instructions (consistent with, and containing references to, the organization's environmental manual) defining the manner of conducting the activity, whether by the organization's own employees or by others acting on its behalf. Such procedures and work instructions shall be prepared for situations in which the absence of such instructions could result in infringement of the environmental policy.

b) Procedures and work instructions dealing with procurement and contracted activities, to ensure that suppliers and those acting on the organization's behalf comply with the organization's policy requirements that relate to them.

c) Monitoring and control of relevant process characteristics (e.g. effluent streams and waste disposal).

d) Approval of planned processes and equipment.

e) Criteria for performance, which shall be stipulated in written standards.

4.8.3 *Verification, measurement and testing*

The organization shall establish and maintain procedures for verification of compliance with specified requirements (e.g. in the programme, targets, manual and work instructions) and for establishing and maintaining records of the results.

For each relevant activity or area, the organization shall:

a) identify and document the verification information to be obtained, and specify the accuracy required of results;

b) specify and document the verification procedures, and the locations and times of measurement;

c) establish, document and maintain quality control procedures, including calibration and quality control charts, and maintain records thereof;

d) establish and document procedures for data handling and interpretation;

e) establish and document acceptance criteria and the action to be taken when results are unsatisfactory;

f) assess and document the validity of affected data when verification systems are found to be malfunctioning;

g) safeguard measurement and test facilities from unauthorized adjustments or damage.

4.8.4 *Non-compliance and corrective action*

The responsibility and authority for initiating investigation and corrective action in the event of non-compliance with specified requirements relating to the environmental management system and environmental performance shall be defined.

The organization shall establish and maintain procedures for such investigation and corrective action, by which the management of the individual function or activity concerned, in consultation with the management representative (or a nominated deputy), shall:

a) determine the cause;

b) draw up a plan of action;

c) initiate preventive actions commensurate with the nature of the non-compliance;

d) apply controls to ensure that any preventive actions taken are effective;

e) record any changes in procedures resulting from corrective action.

4.9 Environmental management records

The organization shall establish and maintain a system of records in order to demonstrate compliance with the requirements of the environmental management system, and to record the extent to which planned environmental objectives and targets have been met.

The organization shall establish and maintain procedures for the identification, collection, indexing, filing, storage, maintenance and disposition of environmental management records. Pertinent contractor and procurement records, and the results of audits and reviews (see 4.10 and 4.11) and training records (see 4.3.4) shall form an element of these records.

All environmental records shall be legible and identifiable to the activity, product or service involved. Environmental records shall be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration or loss, and their retention times shall be established and recorded.

Procedures shall be established and implemented regarding the availability of records, both within the organization and to interested parties.

4.10 Environmental management audits

4.10.1 *General*

The organization shall establish and maintain procedures for audits to be carried out, in order to determine:

a) whether or not environmental management activities conform to the environmental management manual, programme, procedures and work instructions, and are implemented effectively;

b) the effectiveness of the environmental management system in fulfilling the organization's environmental policy.

For this purpose, the organization shall establish and maintain an audit programme.

4.10.2 *Audit programme*

The audit programme shall deal with the following points.

a) The specific activities and areas to be audited, which include:

1) organizational structures;

2) administrative and operational procedures;

3) work areas, operations and processes.

b) The frequency of auditing of each activity/area, audits being scheduled on the basis of the contribution, both actual and potential, of the activity concerned to significant environmental effects, and the results of previous audits.

c) The responsibility for auditing each activity/area.

4.10.3 Audit protocols and procedures

The audit protocols and procedures shall deal with the following points.

a) Documentation, reports and records.

b) Environmental performance.

c) Personnel requirements, and specifically that those carrying out the audits:

1) are sufficiently independent of the activities they audit to make an objective and impartial judgement;

2) have sufficient expertise in relevant disciplines;

3) have support, where necessary, from a wider range of specialists, who may be internal or external to the organization.

d) Methodologies for conducting the audits, which may involve the use of questionnaires, checklists, interviews, measurements and direct observations, depending on the nature of the function being audited.

e) Procedures for reporting audit findings to those responsible for the activity/area audited, who shall take timely action on reported deficiencies. Reporting shall address:

1) conformity or non-conformity of the environmental management system elements with specified requirements;

2) the effectiveness of the implemented environmental management system in meeting objectives and targets;

3) implementation and effectiveness of any corrective actions recommended in previous audits;

4) conclusions and recommendations.

4.11 Environmental management reviews

The organization's management shall, at intervals it determines, review the environmental management system adopted to satisfy the requirements of this standard, to ensure its continuing suitability and effectiveness. This review shall be documented. The environmental management review shall also address the possible need for changes to the policy and objectives, in the light of changing circumstances and the commitment to continual improvement.

Resource Protection: Environmental Protection
Resource Requirements Summary

The following outlines the resource requirements that are needed to bring WSC into complete compliance with the regulations set out in WSC's Register of Regulations and Corporate Policy 500.17: Protection and Enhancement of the Environment. Resources are needed to:

(A) continue the implementation of WSC's Environmental Management System

(B) continue work on the environmental database

Resource requirements will be given as in the following example:

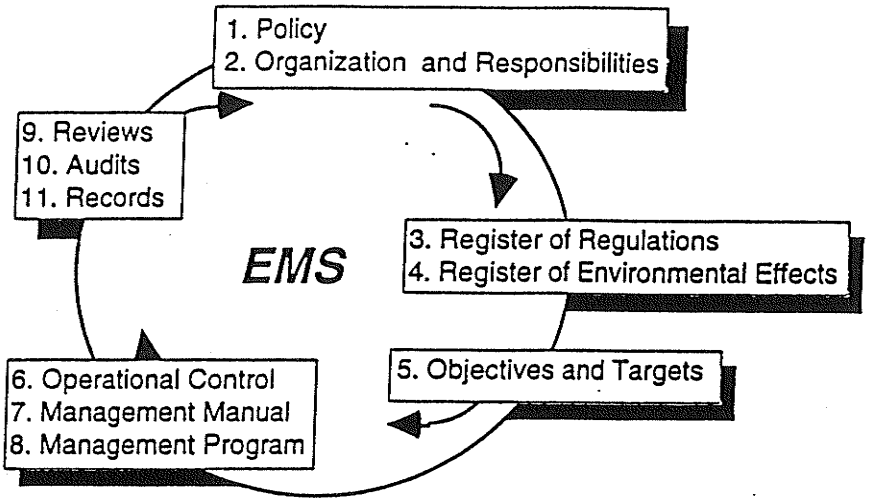
Resource Protection	Location - Other	Corporate - C
.5	LO = 5	C

This means Resource Protection requires .5 weeks to complete the task, another party at the location will have to contribute .5 weeks and some work is required at the corporate level.

In total there are 108.3 weeks of initial and 13.6 weeks of annual Resource Protection time required. There are at least10 further weeks if Health and Safety considerations are added and CS 7000 procedures drafted and implemented. There are 11.1 weeks of other location personnels' time required (for instance Facilities, Procurement, etc.). Corporate time is also required but is not broken down here.

108.3 + 13.6/yr + 10*+	LO = 11.1	C
Telephone +		
Transportation $		

A. Looking at each of the stages of the EMS process reveals a need for attention to a number of items. These stages are:



1. The Corporate Environmental Policy is in place.

- Further discussion needed on inclusion of Montreal Protocol, ICC Sustainable Development Principles, "continual improvement" clause, etc.

0 LO = .2 C

- Keep drafts of corporate standards and policies current

.2

- Establish medium for communicating progress to employees

.5

2. Organization and Responsibilities.

- Senior managers to define roles and responsibilities.

0 LO = .5

3. Register of Regulations

- Add 'Resource Use' and 'Real Estate' categories

.2

- Add 'Health and Safety' categories (depends upon ISO standard)

5.0*

- Add ICC, Montreal, etc.

.2

- Semi-annual review for up-dates

1.0/yr.

- Maintenance

.2/yr

4. Register of Environmental Effects

- Add 'Resource Use' and 'Real Estate' categories

2.0

- Add 'Health and Safety' categories (depends upon ISO standard)

5.0*

- Add ICC, Montreal, etc. (depends upon discussion in #1 above)

1.0

- Semi-annual review for up-dates

1.0/yr

- Maintenance

3.0/yr

5. Objectives and Targets

- Review to establish objectives and targets (including preparation of all participants)

.2 LO = 1.0 C

6. Operational Control. Control, verification, measurement, and testing.

Procedures required:

- Requirements from Register of Environmental Effects (Appendix A)

19.6 + .4/yr 4.4 C

- Implementation of above (@ 3:1)

58.8 n/a n/a

- Continued implementation and maintenenance of above (@ 1:1)

19.6 n/a n/a

- Procedures for compliance with Corporate Standard 7000 (Appendix B)

Future C

- Implementation of above (@ 3:1)

Future n/a n/a

- Continued implementation and maintenenance of above (@ 1:1)

Future n/a n/a

7. Management Manual

- Design, development, editing and approval .

3.0 LO = 1.0

8. Management Program. Functional responsibilities outside of Resource Protection Dept.

- On-going monitoring of activities

0 LO = 1.0

- On-going evaluation of new activities .

0 LO = 1.0

9. Reviews

- Discussion of EMS

1.0

10. Audits

Internal:

2.0/yr C

- Organizational
- Administrative
- Work areas

External:

2.0/yr C

- Suppliers
- Contractors

11. Records

4.0/yr

- Collection
- Maintenance

The list has been prioritized based on the number of times that the requirement appears in the Register, if it satisfies a due diligence requirement, and the author's perception of the importance of the requirement in the overall environmental management scheme.

Total for Appendix A:

19.6 + .4/yr **LO = 4.4** **C**

DD - denotes an environmental due diligence requirement

1. Scope of Environmental Considerations in Business Areas (DD)

Broaden scope of environmental considerations in business areas. The emerging environmental management system standards are similar to those of quality management system standards - they are all-entailing and in the true sense systematic. Environmental awareness should be stimulated just as was quality awareness. Could be incorporated into such things as MFA's.

2.0

2. Materials Handling: Procurement, Storage and Transportation Procedure

A Materials Handling: Procurement, Storage and Transportation Procedure is needed to formally address the identification, marking, storage, transportation and, in some cases, the disposal of WSC substances which have the potential for harmful environmental effects. Besides inspections, audits, and record-keeping, the above procedure should also ensure that the hazardous materials location list is kept current. It should be noted that WSC's operation is in compliance with almost every environmental regulation, with the exception of the manner of storage of certain goods and the quantities stored of these goods.

.5 (MCS may have)

3. Environmental Risk Analysis (DD)

An environmental risk analysis is needed. One of the primary purposes of the environmental management system is to prepare for the unexpected. A risk analysis makes statistical determinations and stimulates in-depth thinking in aid of such preparation.

2.0

4. NT Corporate Environmental Policy (DD)

The NT Corporate Environmental Policy should be adhered to more closely. Many of the shortcomings that WSC has in the area of environmental protection could be improved at the source if there was a wider recognition and active implementation of the NT Environmental Policy.

.5 C

5. Materials Handling: Vendors' Procedure

Similar to the above, but aimed at WSC associates rather than WSC personnel, is the Materials Handling: Vendors' Procedure. This is needed to control and monitor the activities of janitorial, food service, landscaping, and numerous other personnel for whom WSC is indirectly responsible.

.5

6 & 7. Resource Protection: Vendor/Product Reporting Procedure

A Resource Protection: Vendor Reporting Procedure and a Resource Protection: Product Reporting Procedure are required. The Resource Protection department is currently unable to make determinations, and hence proper decisions under its jurisdiction, on the activities of its associates and the environmental effects of its products without complete information. This procedure requires Facilities, Procurement, or any other appropriate department to report to Resource Protection on any environmental considerations which might arise in the course of a day's business activities.

1.0

8. Resource Protection Product Input (DD)

More input by Resource Protection should be made into the product gating and development process. Considerations regarding the use of harmful substances, non-compliant suppliers, in-efficient use of resources, and minimization of waste such as packaging are all in the domain of Resource Protection and are best addressed at this early stage.

.5

9. Incident Management Procedure (DD)

The current Incident Management Procedure should be improved to incorporate the requirements of the Director's release reporting procedures and focus more on environmental concerns.

.5

10. Emergency Response Assistance Plan (DD)

The Emergency Response Assistance Plan should be extended to include equipment inspections and inventory tracking of items such as absorbents. The ERAP documentation should also include the government's threshold quantities of goods and this should be kept current.

.5 + .2/yr

11 & 12. Point Source/Non-Point Source Inspection and Monitoring Procedure

Both Point Source and Non-Point Source Inspection and Monitoring Procedures are required. Point source discharges include the release of substances leaving WSC by the City's sanitary sewer system. Regular liquid effluent testing is required. Non-point source discharges include herbicides, fertilizers, possibly pesticides, and petroleum hydrocarbons emanating from vehicles occupying the parking lots. A regular testing program is warranted to ensure the pollution reduction goals of Northern Telecom.

1.0

13. Associates' Compliance and Approvals Confirmation List

An Associates' Compliance and Approvals Confirmation List is required. Audits of suppliers' and service contractors' environmental regulatory compliance are often only as good as the word of those parties. The appropriate authorities must be questioned about the track records of WSC associates. Further, the authorities will also know whether or not associates' activities are subject to government approval.

1.0 **C**

14. Facilities Change: Reporting Procedure

A Facilities Change: Reporting Procedure is needed to keep Resource Protection apprised of activities which could result in harmful environmental effects. This is especially important if an expansion is planned or a structure vacated.

.5

15. Chemical Storage Room

Changes are needed in the area of chemical storage. The chemical storage room should either exist as a satellite to the main plant or a waterproof door installed and dry extinguishers put in place of the present wet extinguishers. This is because there is a good chance that hazardous

materials would be dispersed throughout the plant via the high volume of extinguishing water emitted during activation of the fire protection system.

0 LO = 3.0 C

16. Public Interaction Reporting Procedure (DD)

Often the best solutions to a problem and the earliest indications of a problem come from employees and the public at large. Yet no formal mechanism exists to log employee and public input into environmental matters, although this is mandated in the NT Corporate Environmental Policy. A Public Interaction Reporting Procedure is suggested to rectify this situation. Records of WSC's environment-oriented program involvement with various associations, organizations and the community should also be generated by this procedure.

.5 C

17. Product Information Determination Procedure

A Product Information Determination Procedure is needed in order to ensure that incoming and outgoing goods are both properly labeled and accompanied by the proper Materials Safety Data Sheets (MSDS). The age of MSDS's and a tracking system should also be addressed when designing and implementing this procedure.

1.0

18. Hazardous Substances Tracking Procedure

A Hazardous Substances Tracking Procedure is required to track National Pollutants Release Inventory (NPRI) substances, as the list will grow and thresholds lower. Formal recognition at WSC should be made of these substances, deemed by the federal government to be environmentally harmful. This would aid in the reduction and eventual elimination of these substances.

.5 LO = .5

19. Tracking of Lead Emissions

WSC's most damaging air-emitted substance appears to be lead. Although below government limits, the emission of lead is not tracked. Tracking lead emissions is the first step toward the reduction of these emissions.

.5

20. Tracking of Waste Manifests

The tracking of waste manifests should be more actively pursued. The exact destination and time of arrival of hazardous waste emanating from WSC must be determined to ensure safe disposal of these materials.

- Appendix 6 -

Nitrogen Inerting for Wave Soldering
Capital Funds Appropriation

MATERIAL:	**Soldering** (US Dollars)	
	Air (current)	N_2 (proposed)
1. solder bar	$15,630	$9,378
2. dross reclaim	($470)	$0
3. nitrogen	$0	$11,167
4. flux		
5. solvent		
6. waste		
Sub-Total	$15,160	$20,545

(Exerpted from Northern Telecom WNC, 1994.)

"How to Include Environmental Costs into Wireless Networks Calgary Decisions - A Practical Guide"

prepared for Northern Telecom WNC
by Jeff Everett
Natural Resources Institute
University of Manitoba

May, 1995

Introduction

Much is being written these days about the need for companies to become more 'green'. Many of the discussions revolve around the harmful effects that businesses have on the environment, and what these businesses should do to improve their performance. However, there is a lack of information on how companies can practicably implement these suggestions. The need for this information is greater now that it has ever been, as consumer's environmental awareness grows, environmental legislation strengthens, and companies begin adopting international environmental business standards.

This guide provides some of the environmentally-related information that a decision-maker needs to include when he or she makes a financial business decision. With this guide previously ignored costs are identified so that they may be taken into account when competing options are compared or when everyday operations are analyzed. Admittedly, this increases the complexity of decision-making, but with experience and practice, the consideration of the environmental costs involved in WNC operations will become easier.

The Environmental Protection Cost Framework

The first task in dealing with environmentally-related costs is to identify them. This is not particularly easy as many of these costs are hidden—incurred without our notice—and even if noticed escape our ability to place dollar figures upon them. Not only this, environmental costs may be imposed by WNC via entities other than WNC products and processes. Suppliers, product designers, contractors and vendors, and even employees may all act as 'vectors' for the imposition of WNC's environmental costs.

Once a cost has been identified, the other task is to properly handle it. One has to consider, for instance, whether or not WNC wishes to assume responsibility for the cost (i.e., capture or internalize it). The philosophical question of how much cost a firm is to internalize has been much debated; nevertheless, the current era suggests an ever expanding role and greater responsibilities for businesses. So as times change, perhaps more of these costs have to be 'captured'. In deciding whether or not to capture a given cost, the decision-maker may have to refer to the corporate environmental policy, or a higher organizational authority.

Having decided that a cost is indeed the responsibility of WNC, it must then be accounted for. To do this the first thing that must be done is to quantify or estimate the cost. If the cost can not conceivably have a monetary value placed upon it, then it must simply be acknowledged and assigned a narrative or verbal descriptor. If the cost can be quantified, but only roughly, a range of values should be assigned to it, along with a narrative descriptor. Finally, if the cost can be reasonably estimated, it should be handled using the WNC management accounting and financial techniques of capital budgeting (capital funds appropriation, net present value, etc.) or activity-based costing (ABC). Generally speaking, if the cost is a one-time cost it should be handled through capital budgeting; if it is an on-going cost, then ABC is preferable. To facilitate this thought process, a framework was developed and appears in Figure 1.

The EPC framework reads from left to right, according to the process of: identifying cost vectors, identifying the cost and ownership of the cost, and then deciding on how to handle the cost. At each of these three steps the decision-maker asks certain questions.

Step 1. Identify cost vectors.

Q. Looking at the list of entities under item 1 in the framework, the decision-maker asks the question: if a given option is followed, WNC will impose costs on society and/or the environment through which entities: suppliers? designers? vendors? etc.

Step 2. Identify cost and ownership of cost.

Q. Looking at the list of costs under item 2 in the framework, the decision-maker asks the questions:

(1) of all the possible costs, which one(s) would be relevant if this option is followed?

(2) regarding the ownership of the cost(s), if this option is followed, will the relevant cost(s) be incurred by WNC or passed on to outside parties? That is, which costs do we as a firm capture (internalize)?

Step 3. Decide on how to handle costs.

Q. The relevant costs may be of an on-going or a one-time nature. If they are of an on-going nature, the decision to incur these costs will be made within an operational decision-making framework. If they are of a one-time nature, the decision to incur these costs will be made within a strategic decision-making framework.

The relevant model to be applied in the case of operational decisions is activity-based costing. In the case of strategic decisions, the relevant model to be applied is strategic costing, with its primary analysis procedures of capital budgeting. Thus, the question the decision-maker asks here is: are the costs of an on-going or a one-time nature?

Also, some costs may be easily quantified and put into monetary terms; others not. Often, with some effort, they can at least be estimated. So to account for costs, the decision-maker asks the question: is the cost quantifiable? If so, then it can treated under either the financial analysis technique of capital budgeting or the cost accounting technique of activity-based costing, If not, the cost can be assigned a verbal or narrative descriptor.

Through this identification and decision process, costs which were previously unrecognized can be brought into WNC's financial decision-making and cost accounting system. Further, by using the framework repeatedly, costs which have typically not been captured (internalized) will be able to be captured, according to the changing perception of WNC decision-makers.

The Contingency Decision Tree and the Risk Factor Determination Models

Often costs involve a probability of occurrence, i.e., they *may* be incurred. In these cases the *actual* cost is the product of the probability and the likely cost. An example of this occurs when WNC faces a fine for being out-of-compliance with an environmental or safety regulation. Suppose it says in the regulation that a breach carries a maximum fine $1000. Suppose further that WNC as a corporate citizen is neither particularly 'bad' nor particularly 'good'. Finally, suppose that WNC has a 50/50 chance of being caught. So while the penalty may be $1000, it should only be carried on the books as a 'contingent liability' of $250 ($1000 x .5 x .5).

The contingency decision tree (Figure 2) is used to visually demonstrate this probability/cost situation. Xu is the $1000 maximum fine, p is the 'WNC-neither-good-nor-bad' estimate, and π is the 50/50 chance of being caught.

It is not as simple as saying that WNC is neither good nor bad, however. So an additional model, the risk factor determination model (Figure 3), is needed. This model is used to determine 'p' in the contingency decision tree above.

Conclusion

The framework and models depicted in the guide are not intended to be used rigorously or strictly adhered to. They are designed only to: (1) stimulate thinking about some of the 'other' costs involved in WNC's day-to-day operations, and (2) facilitate the task of estimating the amount and magnitude of these costs. Thus, one should not expect the framework to provide hard and fast numbers or definitive answers. This should not be surprising; the fact that there are so many unresolved issues relating to environmental management has much to do with our inability to 'compartmentalize' and quantify our surroundings.

A more detailed description of the framework and general environmentally-related business issues are documented in the author's complete study, which is available from WNC Resource Protection. For other information refer to WNC's environmental management system.

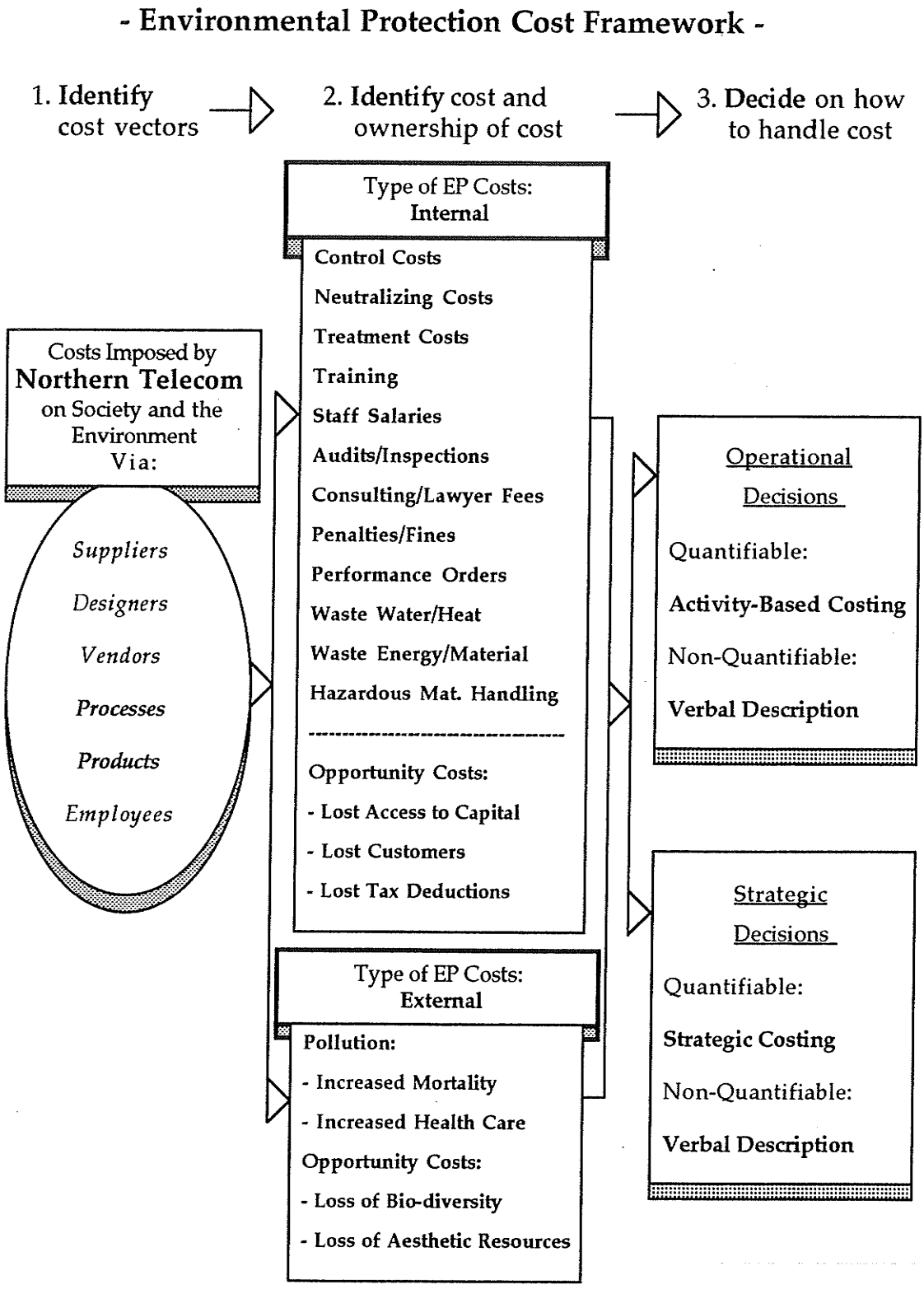


Figure 1 - The Environmental Protection Cost Framework

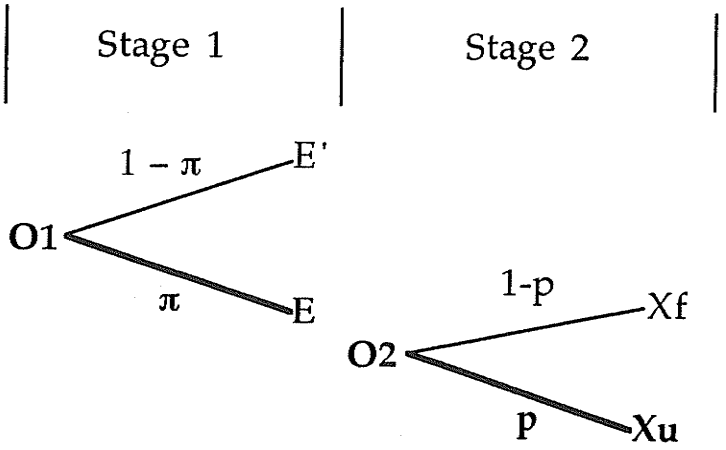


Figure 2 - The Contingency Decision Tree

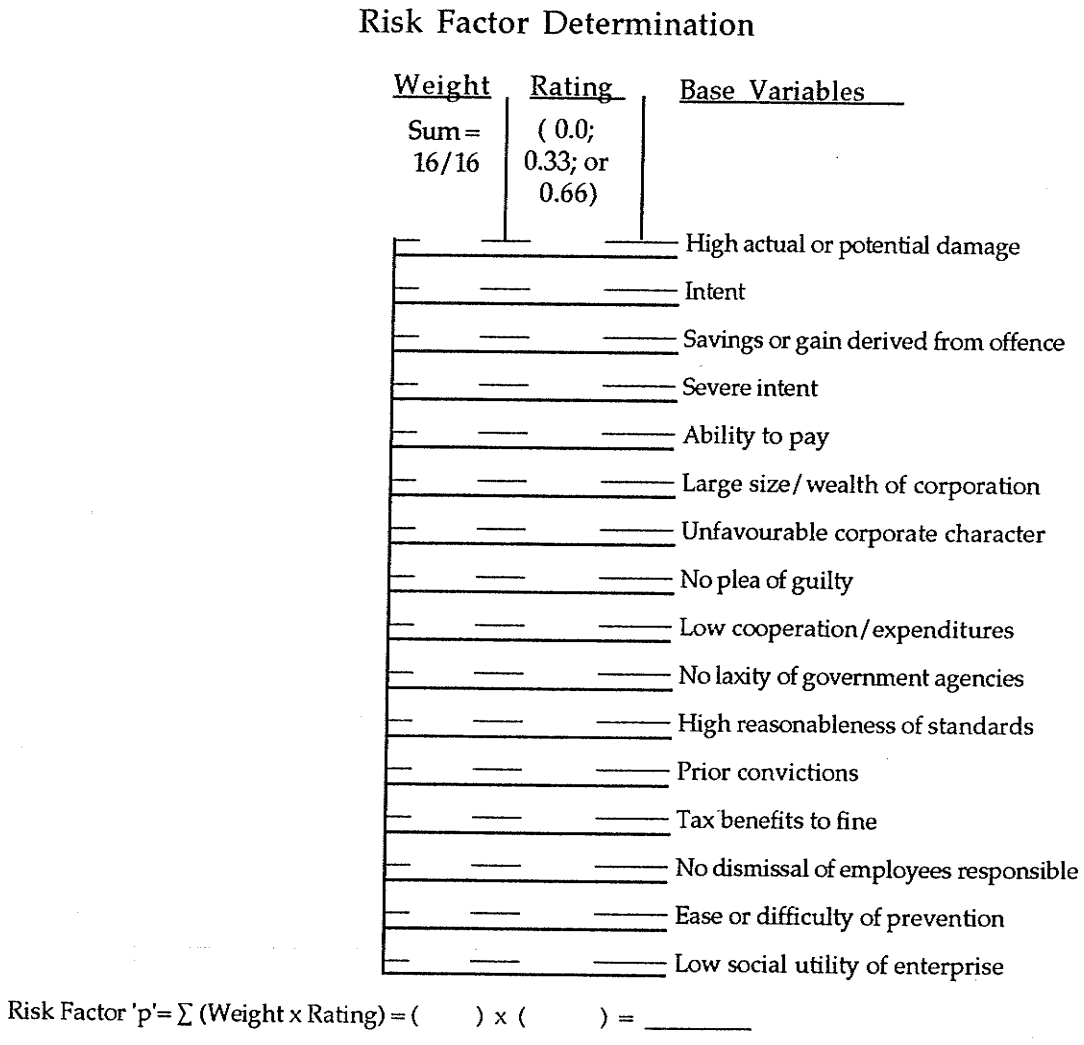


Figure 3 - The Risk Factor Determination Model