POLLUTION PREVENTION PRACTICES IN SMALL AND MEDIUM-SIZED METAL FINISHERS

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ABSTRACT

The recent incorporation of pollution prevention provisions into environmental legislation are leading companies large and small – alike to work towards developing and implementing pollution prevention practices. In order to respond to the challenges of pollution prevention within small and medium-sized enterprises (SMEs), this paper analyzes pollution prevention practices incorporated by four SMEs in the Metal Finishing Sector to gain insights into why and how they embraced the concept of pollution prevention. A qualitative research study was conducted to obtain viewpoints of SME representatives on the challenges and benefits they encountered during the implementation of pollution prevention practices, while exploring the incentives that prompted them to implement proactive measures. The data compiled for the analysis were gathered through a Questionnaire provided to the Environmental Managers of SMEs, and from semi-structured interviews with them. According to the SME representatives, their top three incentives for implementing P2 practices were: 'Improve Environmental Performance', 'Knowledge of Benefits' (e.g. cost reductions), and 'Regulatory Pressure'. Not only did the participants link pollution prevention practices to their obvious benefits to the environment, but also recognized the value-added benefits of such practices to the business bottom line. Furthermore, the experiences of four SMEs suggest that their top two challenges for implementing P2 practices are 'Unavailability of Technology' and 'Longer Payback Periods'. Major findings indicate that SMEs within the Metal Finishing Sector had unique interests and thus handled their pollution prevention activities differently. All the participating SMEs had implemented pollution prevention measures to some extent. However, their methods and approaches varied due to differences in company size, their management practices, unique culture and behavior, availability of knowledge, and financial capabilities of each SME metal finisher.

INTRODUCTION

Since the early 1990s, there has been a major shift from relying on the typical "command and control" regulatory strategies to a focus on pollution prevention as the new environmental protection approach. Industrial facilities have been the primary focus of the government in achieving environmental protection through elimination or reduction of the root causes of pollution, or pollution prevention. The recent incorporation of pollution prevention provisions into environmental legislation such as the *Canadian Environmental Protection Act* (CEPA) of 1999 and in Toronto's *Sewer By-law* (March 2000) are leading companies both large and small to work towards developing and implementing pollution prevention strategies. These legislative requirements compel the companies to systematically examine their production processes to identify the best method(s) for them to prevent pollution. However, as there is great flexibility allowed by the regulations to arrive at the pollution prevention goals set by the companies themselves, the pollution prevention practices may vary from business to business. As suggested by Illomaki & Melanen (2001), enterprises in the same sector, under the same external pressures, may come up with different solutions to cope with their environmental challenges.

The main purpose of this paper is to analyze the pollution prevention practices incorporated by small and medium-sized enterprises (SMEs)[1] in the Metal Finishing Sector, in an attempt to minimize their adverse impacts on human health and the environment. The vast number of SMEs in Canada[2] indicates that cumulatively, SMEs have the potential to significantly impact the quality of our environment. In fact, a recent study conducted by the Ontario Centre for Environmental Technology Advancement (OCETA)[3]

[1] SMEs are firms with fewer than 500 employees and annual revenues of $50 million or less (Canadian Federation of Independent Business, 2002). This classification also matches that of Statistics Canada. In this study, they have been grouped together as small and medium sized firms so that a useful comparison can be made with other research results in the literature. However, they may be individually compared according to their sizes. In such a case, business having less than 50 employees will fall under the small business category, while those having 51-500 employees will be termed medium.

[2] 94% of the business in Canada (2.6 million) have fewer than 20 employees and fall under SME category (Certified General Accountants Association)

[3] OCETA is a not-for-profit corporation that is committed to the delivery of programs to promote the adoption of Sustainable Development and Pollution Prevention Practices by Ontario SME manufacturers. It maintains its public policy mandate of providing business services including environmental technology verification, to entrepreneurs, start-up companies, and SMEs to assist the process of commercializing new environmental technologies [OCETA Home Page, retrieved on August 8, 2002 from the World Wide Web: http://www.oceta.on.ca]

(2002) revealed that eighty-seven *per cent* of industrial sources reporting to the National Pollutants Release Inventory (NPRI) in Ontario are small and medium-sized manufacturers having fewer than 500 employees at the facility level, and 62% of the discharged pollutants and wastes come from these SME manufacturers.

Many authors (Dvorak *et al.*, 2003; Gombault & Versteege, 1999) have argued that SMEs do not understand pollution prevention and in practice may face difficulty in implementing structural changes in their production systems due to their limited financial, technical, and human resource capabilities. This major paper mainly focuses on a research study that was conducted with four SMEs in the Metal Finishing Sector to gain insights into why and how they embrace the concept of pollution prevention. Having recognized the challenges of pollution prevention within SMEs, the study attempted to get the viewpoints of SME representatives on the challenges and benefits they encountered during the implementation of pollution prevention practices, while exploring their motives for initiating proactive measures.

This paper begins by providing a general understanding of the concept of pollution prevention and discusses the benefits, challenges, and the regulatory requirements pertaining to pollution prevention based on the findings of reviewed literature. Subsequently, the basic industrial processes in the metal finishing industry along with the applicable pollution prevention practices are reviewed. The main focus of the paper -- the research study -- is introduced in section 4.0 along with its objectives and methodology. The final section summarizes major findings and conclusions of the study, and suggests recommendations for the participating SMEs and governments involved.

It is hoped that the insights from this major paper will not only expand the boundaries of P2 knowledge within SMEs in the Metal Finishing Industry, but also motivate SMEs in other sectors to incorporate pollution prevention as a sustainable business strategy in the near future.

1.0 Background - The Concept of Pollution Prevention (P2)

1.1 What is Pollution Prevention

Most early environmental protection programs introduced by industrialized nations focused on cleaning up environmental damage after the fact or on applying the 'end-of-the-pipe' solutions to comply with government policy and standards. By definition, these end-of-the-pipe measures ensured that pollution was managed after it had been created. This environmental strategy -- pollution control -- improved environmental quality to a certain extent, but in general failed to eliminate pollutants from the interconnected environment. Often it promoted a "toxic shell game," transferring pollutants from one medium to another (Shen, 1999). Since the early 1990s, the concept of pollution prevention has extensively evolved; the focus has shifted away from managing pollution to preventing it. Today, both government and industry recognize the necessity to 'move-up-the-pipe,' to avoid, eliminate, and reduce pollution at the source. This is pollution prevention (P2).

To date, there is no universally accepted definition of pollution prevention. Professionals in various organizations have defined it based on their own understanding and applications, resulting in somewhat different interpretations. One of the most important issues with respect to defining pollution prevention is whether a pure approach is taken to include only those measures that avoid, reduce or eliminate the "use and generation" of pollutants/waste at the source, or whether any measure is taken to avoid, reduce, or eliminate the "release" of pollutants into the environment, including the pollution control measures (Environment Canada, 1994). The former approach or the "environmental perspective," is an appropriate one as it generally makes more sense for polluters to avoid the creation of pollutants/waste in the first place, rather than for them to develop extensive end-of-the-pipe schemes for pollutants/waste already generated. This thereby minimizes the risks associated with the production of these harmful substances to human health and the environment. The latter approach is really the "industry perspective" of characterizing P2 that argues that a substance cannot be a pollutant until released into the environment (Environment Canada, 1994). The key issue from this perspective is not what substances are used, but how the release of these substances is managed to ensure no harmful effects on human health and the environment.

In simple terms, pollution prevention is any action which reduces or eliminates the creation of pollutants/waste at the source (Bishop, 2000). The Canadian Council of Ministers of the Environment (CCME)[4], have also adopted a similar definition of pollution prevention:

> *The use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and wastes at the source* (CCME, 1996).

This definition is the same as the one mandated in City of Toronto's new Sewer Use By-law (2000). The keywords in both these definitions are "at the source" -- for all the pollution that is avoided in the first place, there is that much less pollution/waste to manage i.e. recycle, treat, or dispose of.

1.2 What is NOT Pollution Prevention?

Applying pollution prevention strategies will not eliminate all the toxic pollutants and waste from the environment. The pollution control measures taken after these substances are generated are not to be considered as pollution prevention (Shen, 1999). Although in-process or closed-loop recycling[5] practices qualify as pollution prevention, most of the legal definitions of pollution prevention exclude on-site or off-site recycling, treatment, and disposal measures, as these are taken after the pollutants are generated.

[4] CCME is Canada's premier forum for intergovernmental discussion and action on environmental issues, which comprises of environment ministers from the federal, provincial and territorial governments. Its primary mandate is to improve environmental protection and promote sustainable development in Canada.
[5] See 'Glossary' for definition. This term also defined later in this Chapter.

However, recycling and reuse of materials are the preferred alternatives for management of residuals after all viable P2/source reduction measures have been implemented. The remaining pollution should be treated to render it less hazardous or toxic, and more compatible with the environment. Disposal into secure landfills should be undertaken only as a last resort.

1.3 Pollution Prevention Practices in Business[6]

Over the last few years, government institutions, the financial and business community, non-governmental organizations (NGOs), and society at large have expressed increased levels of concern for environmental issues. In particular, the significant environmental impact of companies' operations and the scarcity of natural resources have highlighted the importance of a sustainable development concept both from an economic and an environmental viewpoint (Bianchi & Noci, 1998). Under such pressures, firms have adopted different patterns of environmental behavior. Corporate "green strategies" vary from reactive behavior – simply aimed at compliance with stakeholders' requirements - to proactive strategies, whereby executives in the firms attempt to manage the environmental dimension as a significant competitive priority. In such cases, firms take greater initiatives to adopt pro-active measures, thus internalizing pollution prevention practices.

Today, pollution prevention practices are extensively promoted by stakeholders to influence the behavior of companies towards a more environmentally friendly direction. After all, the essence of P2 is consistent with the concept of sustainable development – that is, to reduce the overall environmental burden associated with meeting our needs and carrying out our activities (including economic production), while increasing the efficiency with which we use materials and energy (Phipps, 1995). In fact, the focus of much of the research, public attention, and governmental action regarding pollution prevention has been on industry, since it is a major contributor to environmental problems, and as such, is often targeted to "clean up its act." Further, it is industry that implements P2 – not the government.

'Pollution prevention practices' in this document is intended to imply an act of incorporating pollution prevention methods (i.e. source reduction and in-process recycling) with the aid of tools such as the pollution prevention planning process, and under the influence of management practices[7] that enhance pollution prevention activities within a firm.

1.3.1 *Pollution Prevention Methods*

Pollution prevention serves as an important step in a company's development towards sustainable business strategies[8] (Bruijn & Hofman, 2000). It necessitates the rethinking of the whole corporate approach towards production, and initiates processes through which transformation shall take place -- source reduction and in-process recycling -- the two major components of pollution prevention. Pollution prevention recognizes that pollutants/waste represent an inefficiency in the system and therefore relies on source reduction to address inefficiencies in the production of goods and services at their source. In simple terms, source reduction is any practice that eliminates or reduces the creation of pollutants/waste at the point where they originate (or at the source), while in-process recycling is an activity in which input materials (resources) are recovered and directly reincorporated back into the same production process. This process is also termed closed-loop recycling (Dupont, Theodore, & Ganesan, 2000).

Generally speaking, pollution prevention practices incorporate two methods of source reduction – process and/or product changes (depicted in Figure 1) including in-process recycling of valuable resources on-site. P2 practices such as judicious use of resources through source reduction, energy efficiency, re-use

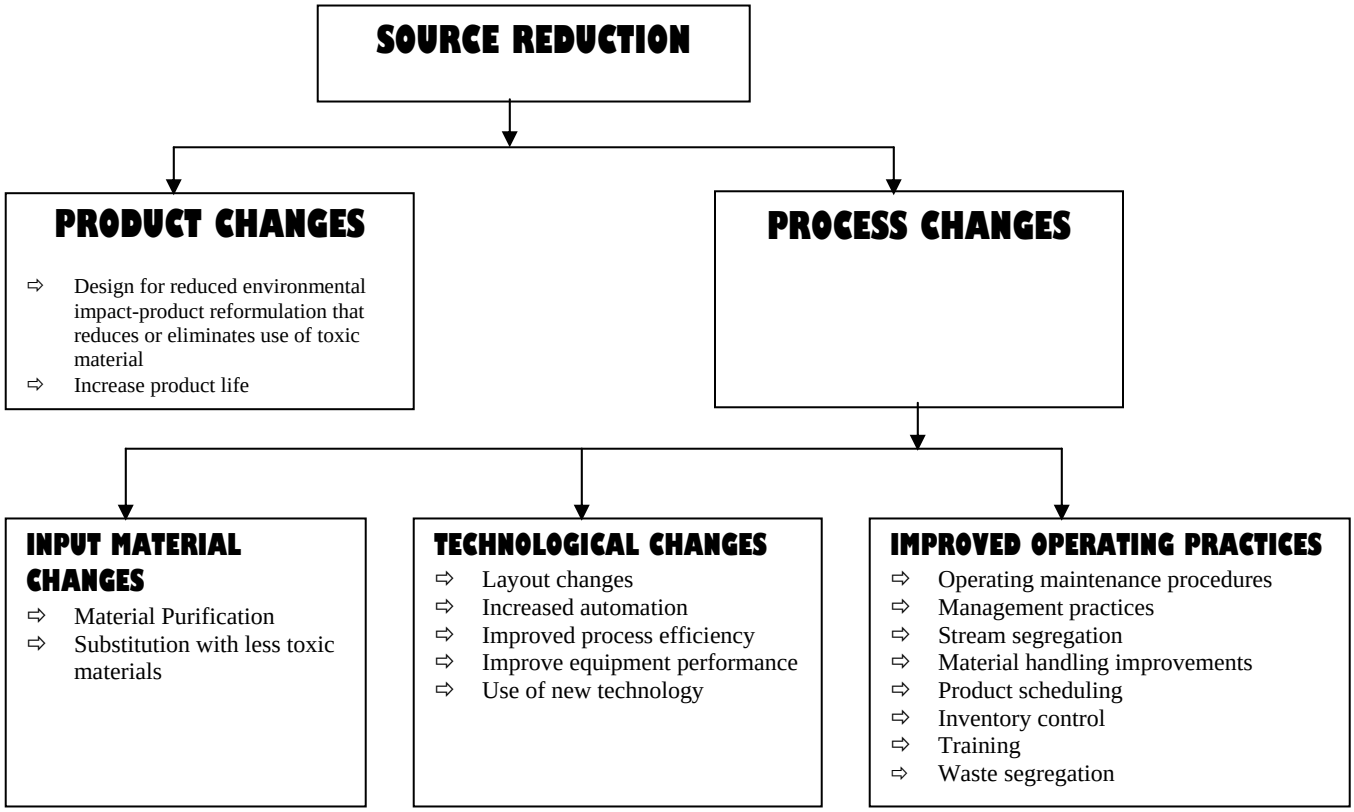
[6] The terms business/company/firm/organization/enterprise/corporate/industrial facility – have all been interchangeably used throughout this paper and are intended to imply commercial or industrial establishment whereby production or manufacturing of goods and services takes place.

[7] This term is intended to imply management responses to various environmental and social issues in business, with the application of various tools, techniques, and procedures to effectively administer the environmental performance of their firms (Wheeler, 2001)

[8] Business strategy defined as "all aspects of a firm's behavior" including approaches to management, human resources, technology, investment, training, and sources of innovation.

of input materials during production, and raw material substitution with environmentally friendly products -- all aim towards sustainable production.

Figure 1: Source Reduction Methods



Source: Shen, 1999, pp. 26

Process changes deal with how the product is assembled. The initiation of process changes require examination of the entire production process in order to institute improvements in operating practices, incorporate technological modifications, and change input materials, where appropriate. Often, decreasing the amount of pollution generated at the source can be as simple as selecting alternative materials for use in the process. In addition, good housekeeping and operating practices such as proper material handling and storage and training of employees can minimize waste generated through preventive maintenance and spill prevention (Shen, 1999).

According to Roy, Boiral, & Lagace (2001), a fair number of solutions to pollution problems are in fact technological solutions. Technological changes involve process and equipment modifications to reduce pollutants/waste primarily in the production setting. Technological changes can range from minor changes that can be implemented quickly and at a low cost, to major changes involving replacement of equipment and processes at a very high cost (Dupont *et al.*, 2000).

Broadening the scope from production process changes to improvements in products is part of industrial transformation (Bruijn & Hofman, 2000). Product changes are performed by the manufacturer with the intent of reducing pollution/waste resulting from a product's production, use, and disposal. These changes generally include redesigning products and reformulating end products to be less toxic (Shen, 1999). However, redesigning products in the industrial sector can be one of the most challenging avenues due to uncertainty surrounding customer acceptance. In addition, product redesign may also require substantial alternations in production technology and input materials. However, refined market research and consumer education strategies such as product labeling could encourage customer support.

Having reviewed various pollution prevention methods, it is clear that pollution prevention calls for a change in the way businesses design their products and operate their existing manufacturing processes. Hence, a fundamental challenge lies in evoking these structural changes in the production and consumption systems. After all, sustainable development can only be achieved if these types of changes are realized.

2.0 Benefits, Challenges, and the Regulatory Regime of Pollution Prevention (P2)

Pollution prevention is often touted as an "economically advantageous, strategically wise way for companies to protect the environment while protecting themselves from future liabilities" (Phipps, 1995). However, P2 actions also face many barriers. To provide a balanced view, the following sections discuss the potential benefits as well as the challenges of implementing pollution prevention measures, highlighting issues that are particularly sensitive for SMEs, the main focus of this paper. Finally, the latter sections will provide an overview of the incorporation of P2 into the current environmental regulatory system.

2.1 Benefits of Implementing Pollution Prevention (P2) Practices

Dr. Joseph Ling of 3M Corporation was the first to introduce the concept of P2 when he initiated the "Pollution Prevention Pays" (3P) program in 1976. The three goals of the program were to (1) achieve environmental improvement, (2) lower the company's costs, and (3) provide a means for employees at all levels to get creatively involved in the prevention of pollution (Phipps, 1995). Firms that are incorporating pollution prevention into their business strategy are finding that that it pays off (Dipeso, 2000). Apart from its obvious benefits to the environment, the integration of P2 results into various benefits for the organization, whether large or small (Ontario Ministry of Environment and Energy, 1993; Phipps, 1995):

- **Reduced Operating Costs -** Perhaps the most attractive benefit of P2 to business is the potential for cutting costs and saving money. Pollution prevention has been known to reduce production costs through process efficiencies such as minimized waste of input raw materials and energy required, thereby reducing materials and energy costs throughout the production process. In addition, by substituting toxic chemicals with safer alternatives and minimizing the use of these harmful substances, a company can reduce the amount of toxic waste produced at the facility, and thus decrease the waste management costs associated with the treatment and disposal of the toxic pollutants/waste. Furthermore, P2 activities can cut down on the costs of complying with the regulatory reporting requirements. For example, if a pollutant is eliminated from a production process, the compliance and reporting activities associated with that pollutant may also be eliminated (e.g. National Pollutant Release Inventory (NPRI) Reporting).
- **Reduced Legal Liability** – Preventing the use and generation of toxic pollutants/waste that cause harm to human health and the environment is a logical way for a company to protect itself from future liabilities such as criminal penalties, corporate fines, and remediation costs. In addition, P2 actions can also improve the occupational environment of a firm, thereby reducing health and safety risks for its workers.
- **Reduce Risk of Non-Compliance and Demonstrate Due Diligence** – By demonstrating pro-active actions, firms can keep up to date with the requirements of current environmental legislation while reducing the risk of non-compliance. Moreover, such activities also build a reputation with government officials who recognize the firm's efforts to improve the quality of the environment, and judge them by the actions performed in the past or their current pro-active measures. Therefore firms end up building good relationships with their local authorities.
- **Improved Corporate Image by Demonstrating Environmental Excellence** – Pollution prevention can also serve as an effective public relations tool. Today, companies are increasingly demonstrating an active commitment to reduce their environmental impacts and are engaging in positive relationships with their stakeholders such as local community members, customers and suppliers. As more and more consumers are becoming aware of the environmental impacts of the products they buy, a company can use its environmental performance and its demonstrated concern for human health and environment to improve its marketing efforts, and establish itself as a socially responsible member of the community.
- **Benefits of the P2 Planning Process** – It has been reported that employee involvement in the P2 planning process can lead to an increased knowledge of the company's production operations and sources of pollutants/waste generated throughout the production processes, thereby leading to a

more planned approach to eliminating or reducing pollutants/waste (Steering Committee, British Columbia Pollution Prevention, 1999). Furthermore, the baseline review process has been noted to bring facility employees together to work towards a common goal of preventing pollution, thus creating general awareness of the environmental impacts of the company and in general improving employee morale. However, more importantly, the planning process leads to the assessment of all waste streams and pollution sources within the facility with the identification of significant opportunities to reduce or eliminate the root causes of pollution. Hence, the generation of the subsequent P2 Plan provides a multi-media solution to environmental problems within a facility, as it practically deals with reducing or eliminating air, water, and waste emissions and releases effectively.

- **Improved Product Quality** – In many cases, changes made to eliminate harmful or toxic substances from the product's constituents list may lead to a newer, better product. Thus, such changes lead firms to improve the quality of their final products, and attract green consumers.

2.2 Challenges of Implementing Pollution Prevention Practices

If pollution prevention is such a powerful business improvement strategy, why are companies finding it difficult to adopt? There are a number of barriers that may inhibit the ability of a company to develop, evaluate and implement successful pollution prevention programs. These vary depending on the type of industry involved, size of the company, and its internal culture (Dipeso, 2000). The barriers mainly fall into four main categories: Financial, Institutional, Technical, and Regulatory. Each of these categories is discussed below.

- **Financial Barriers**

The unavailability of capital due to limited financial resources for plant modernization often becomes a significant obstacle to implement P2 option, even if the option will ultimately lead to be profitability (Chiu, *et al.*, 1999). Hence, options with low initial start up costs and shorter payback period are implemented first, dismissing the notion of pollution prevention leading to financial recovery over the long term.

Due to the "must do" characteristics of environmental projects, firms approach environmental investments differently. When the project is perceived as discretionary, managers typically do not believe there is a need for thorough analysis (Epstein & Roy, 2000). In this case, financial evaluation of such projects is limited, as companies typically fail to make a complete evaluation of environmental costs and benefits. Hence, a key barrier to implementing a P2 measure is failure to understand the true costs of not adopting pollution prevention measures, including the "hidden" costs of environmental operations, during economic analysis of pollution prevention projects (Dipeso, 2000). Hidden costs such as waste treatment and disposal charges, permitting fees, record keeping, and potential future environmental liability – could all add up in the end. Large corporations have been experimenting with a number of techniques that can help them to monetize environmental externalities, and to account for uncertainty and risk. Among these techniques are cost benefit analysis, the TCA method, decision trees, and scenario forecasting. However, these techniques are far too complex and require expertise not found in SMEs (Epstein & Roy, 2000). SMEs generally focus their actions on processes which make them economically viable – typically production and sales – and prefer short-term investments with a focus on day-to-day survival, thus neglecting environmental programs which require long-term planning (Bianchi & Nocci, 1998).

- **Institutional Barriers**

Corporate culture, sometimes called an organizational climate or corporate style, can be a valuable tool or, in some cases, a hindrance to the implementation of a pollution prevention strategy (Phipps, 1995). A negative attitude towards changing established industrial processes or practices tends to block new ways of preventing pollution. Managers may be reluctant to take risks with new technologies or may simply be uninterested in changing their habitual ways of doing business (Chiu, *et. al*, 1999). In some cases, customers may demand product specifications that require the use of hazardous materials that generate toxic waste.

The organizational structure can also impede pollution prevention. Environmental management is often regarded as the responsibility of a separate department. In this case, Pojasek (1999) suggests that environmental managers can integrate P2 into core business operations by speaking the language of

other departments. It also pays to get employee input, especially from those who work with the production processes on an everyday basis – who may come up with practical suggestions for dealing with pollution/waste problems.

In addition, the P2 Planning process itself is very time-consuming and requires costly manpower, thus posing a greater challenge to small and medium-sized enterprises (SMEs) (Steering Committee, British Columbia Pollution Prevention, 1999). The SMEs lack the time and expertise (e.g. planning staff and personnel) to analyze their waste streams and emissions, let alone spot possibilities for waste elimination/reduction (Dipeso, 2000). Besides, most SMEs cannot afford to employee an environmental coordinator/green champion or to hire a specialized consultant, and therefore lack the internal motivator for promoting a P2 program. Sadly, their managers are so busy fighting fires that they do not have time to think about strategic long-term issues like environmental management. Compliance with environmental regulations is often their only target in order to avoid problems with local authorities. Many of these firms still live by the misconception that prevention measures cost money; the fact that pollution prevention increases production efficiency and is cost efficient is still not generally understood by them (Gombault & Versteege, 1999).

Very often, overcoming barriers comes down to instituting behavioral changes in a company. Changes in behavior – in the way organizations plan and do business – are at the heart of the pollution prevention approach to environmental protection. The Canadian Institute for Environmental Law and Policy (CIELAP) report (1999), *At the Environmental Crossroads,* describes pollution prevention as being applied to all things at all times. Hence, organizations need to adopt pollution prevention as an attitude and not a point solution. For an organization to sustain a long-term commitment to environmental management, the environment will have to be positioned at a higher level within its values system.

❖ **Technical Barriers**

Limited awareness of P2 issues at the company's decision-making level, lack of in-house expertise on pollution prevention, and the absence of readily available technologies all hinder the adoption of P2 measures (Phipps, 1995). The generation of P2 options for different plant production processes requires the organization to research and collect vast amounts of information on alternate procedures and technologies that are available to them. If new technologies are to be considered, firms may require assistance from experts in the field with the knowledge capacity to integrate alternative technologies into their production processes.

Limited flexibility in current manufacturing processes may pose another technical barrier. If a proposed option requires modifying the work flow, product, or installing new equipment – implementation could require a production shutdown, with loss of production time (Ontario Ministry of Environment and Energy, 1993). New processes may require additional training for employees, with changes in product specifications that could lead to consumer rejection. Often, redesigned products may be less aesthetically appealing to consumers and thus may not sell. Technical barriers can be overcome by using tested technologies or by setting up pilot operations prior to final implementation. Educational campaigns informing consumers about the environmental superiority of the product may prove to be an excellent marketing strategy while enhancing consumer knowledge.

SMEs have limited knowledge of cleaner technologies, and may lack a methodology to help them structurally start improving their environmental performance (Gombault & Versteege, 1999). Furthermore, SMEs may experience difficulty in accessing a central source of information on pollution prevention techniques. The recent development of informational websites such as that of the Canadian Center for Pollution Prevention (C2P2), along with technical journals, association partnerships, and university libraries, are all useful resources which may provide assistance in locating sources of published information with contact names of people who might be able to provide information in specific areas.

❖ **Regulatory Barriers**

Regulations may serve as barriers to adopting pollution prevention measures by steering companies to focus on cookbook, end-of-pipe technologies geared towards compliance with single-medium pollution

standards. Many of the environmental regulations still focus on air emissions, water effluents, and waste generation/management forcing companies to deal with the regulatory requirements first, concentrating on one issue and one regulation at a time. In addition, many companies are subject to environmental regulations from three levels of government. These provisions become rather cumbersome to deal with and are especially confusing for small businesses, which prefer to think of "government" as a single entity organization. A one-window approach is often desired to ease the reporting requirements (P2SBWG, 2001).

Networking with the appropriate regulatory bodies earlier in the planning process may help company personnel to overcome the regulatory challenges. The materials or guidelines issued by regulatory bodies contain important information on how to abide by the provisions of the Act. Affiliations with industry associations and similar business workgroups can also assist organizations to keep up to date with current requirements of legislation, while allowing them to benefit from established knowledge and already implemented programs (Bruijn & Hofman, 2000).

2.3 Pollution Prevention in the Environmental Regulatory System

While the general regulatory apparatus in Canada still focuses on the traditional end-of-the-pipe measures, there have been recent developments in federal and local environmental legislation to incorporate pollution prevention provisions, thus highlighting the importance of pollution prevention to enterprises. However, it is important to note that the majority of these legislative instruments do not distinguish between small and large businesses and require companies large and small alike, to work towards fulfilling their requirements. The remaining sections of this chapter discuss the integration of P2 at different levels of the government.

2.3.1 National Commitment to Pollution Prevention

Within Canada, federal, provincial, territorial, municipal, and Aboriginal governments share jurisdiction for the environment. The Canadian Council of Ministers of the Environment (CCME) comprises environment ministers from the federal, provincial, and territorial governments with a mandate to improve environmental protection and promote sustainable development in Canada (CCME, 1996).

In 1993, the CCME contributed to the evolution of P2 in Canada by declaring it a national commitment and releasing a statement entitled "National Commitment to Pollution Prevention", in which a series of principles were laid out to guide pollution prevention in Canada. In 1995, the release of "Pollution Prevention: A Federal Strategy for Action" set the stage for federal departments to work with the full continuum of society on a range of actions to avoid or minimize the creation of pollutants and waste. In particular, the strategy committed the federal government to "help small and medium-sized enterprises improve their environmental performance." In May 1996, the CCME addressed the P2 issue again by releasing "A Strategy to Fulfill the CCME Commitment to Pollution Prevention" that set out a vision, mission, and goal statement, as well as guiding principles for the implementation of pollution prevention shared by all provinces, territories, and the federal government (CCME, 1996). To show its support for pollution prevention, the CCME presents pollution prevention awards annually to recognize P2 achievements by businesses (categorized into small, medium and large), institutions, municipalities, and other entities and maintains a Pollution Prevention Network that serves as a forum for information exchange among its members on an ad hoc basis (Environment Canada, 2002).

2.3.2 The Canadian Environmental Protection Act (CEPA) of 1999

Pollution prevention is the cornerstone of the renewed *Canadian Environmental Protection Act* CEPA (1999)[9] that uses pollution prevention planning as an instrument to manage toxic substances. The

[9] It is defined in the Act as "the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to the environment and human health." The phrase 'at the source' is missing in this definition.

provisions of this Act give the Minister of the Environment the authority to require a company or facility to prepare and implement pollution prevention plans for a substance(s) declared toxic under CEPA. This requirement could also apply to SMEs when it proves to be the most effective means of dealing with the environmental and human health risks associated with the substance(s). However, the planning provisions under CEPA are not mandatory, and highly dependant upon the Minister's discretion. In fact, companies or facilities 'required' (at the Minister's discretion) to prepare plans under Section 56 of CEPA notice, will not normally have to submit them. Instead, they will need to submit declarations to the Minister affirming preparation and implementation of the plan. In this case, the plans are kept on-site at the facility. Hence, there is flexibility in the form of P2 planning and implementation, which is left for individual companies and facilities to decide.

Most of the CEPA-toxic substances are the same as those mandated under the City of Toronto's Sewer By-law. Hence, firms that are responding proactively to the City's By-law provisions are in one way planning ahead of time to address the CEPA-toxic substance(s), since the majority of CEPA's pollution prevention planning provisions have yet to be applied. However, it is expected that P2 planning will be used extensively as experience is gained with this new piece of legislation. Recently, Environment Canada developed a notice under Part 4 of CEPA (1999) requiring the preparation and implementation of pollution prevention plans for products containing Nonylphenol and it's Ethoxylates (NP and NPEs). The notice published in the *Canada Gazette* Part 1 in the Fall of 2003, targeted manufacturers and importers of soap and cleaning products, processing aids used in textile wet processing, and pulp and paper processing aids that purchase 1000kg or more of NP and NPEs in one calendar year between 2003 – 2012[10].

2.3.3 Pollution Prevention Initiatives in Ontario

Currently, there are no legally binding or mandatory requirements pertaining to pollution prevention planning in the provincial environmental legislation. Instead, the Ontario Ministry of the Environment (MOE) has attempted various non-regulatory approaches to initiate P2 initiatives in the Province mainly through partnerships with industrial associations and private companies[11]. Formal Memorandums of Understanding (MOUs)[12] were developed with five industrial sectors including Metal Finishing to incorporate voluntary P2 planning provisions into business plans to reduce subject pollutants/waste. In 1999, the MOU with the Metal Finishing Industry had 25 signatories that achieved a total reduction of 5,288 kilograms a year of chemicals, metals, and materials (Ontario Ministry of the Environment, 2001). Furthermore, the Pollution Prevention Pledge Program (P^4) encouraged the adoption of pollution prevention planning among various industrial, commercial, and institutional establishments, whereby the participants received certificates acknowledging their reductions in the use, generation and/or release of hazardous wastes and industrial effluents (Ontario Ministry of the Environment, 2001).

While there are no objections to voluntary industry pollution prevention initiatives, there are concerns about employing them as substitutes for, rather than supplementary to, regulatory frameworks. Voluntary initiatives may lack specific and quantitative targets, and are not explicitly designed to be legally binding to the parties involved (Pollution Probe, 1999).

Currently, the MOE is undertaking two "compliance assistance" pilot projects: one with the metal finishing sector and one with the autobody refinishing sector. As introduced by the MOE, compliance assistance is a "best practice tool" used to aid facilities in meeting their environmental legal obligation through technical support and plain-language legislation (Hamilton, 2002). While these projects are generally supported, it

[10] National Office of Pollution Prevention: Working Document Regarding Pollution Prevention Planning for products containing NP and NPEs. Retrieved on November 11, 2003 from the World Wide Web: http://www.ec.gc.ca/NOPP/DOCS/Consult/NPE/en/intro.cfm

[11] It is important to note that mandatory P2 Programs typically require participation and pollution prevention planning from a specified group of facilities, while voluntary programs typically offer incentives for P2 activities to those facilities that volunteer to participate.

[12] MOUs are typically tri-party agreements involving federal and provincial governments and an industry trade association. For example, the Metal Finishing Sector Initiative was a joint government industry project between the Industry Associations, Environment Canada, and the Ontario Ministry of the Environment.

is important to note that they are not specifically designed as P2 tools and only ensure compliance with the provincial legislative requirements – which do not focus on pollution prevention in the first place. Moreover, assistance particular to these projects may be silent with regards to CEPA (1999) or Toronto's Sewer By-law provisions.

In addition, the MOE has also launched Co-operative Assistance Pilot Project -- a series of cooperative agreements targeted at Ontario's environmental leaders -- aimed at companies that are willing to launch new approaches to environmental management. Under these agreements, MOE offers various incentives (e.g. enhanced comprehensive Certificates of Approval, public recognition, reduced paperwork, etc.) to motivate facilities to improve their environmental performance beyond regulatory obligations[13]. Specifically, facilities would work with the Ministry to develop a reduction plan for three to five priority substances. However, participation in these programs is limited to facilities that have an EMS in place, with a completed emissions inventory. It is assumed that large corporations in sectors which have negotiated agreements might benefit from this program, but its criteria may discourage SMEs from participating. Moreover, these agreements are silent regarding P2 – and thus not specifically P2 initiating instruments.

2.3.4 Local Government: Toronto's Sewer By-law (2000)

At the local level, the City of Toronto's Sewer Use By-law 457-2000[14] has recently been amended to control the level of industrial toxic wastes disposed by various industries at the municipal level. The City was the first municipality in Canada to incorporate mandatory pollution prevention planning requirements into the Sewer Use By-law. The new By-law has set new discharge limits for subjected toxic substances (eleven metals and twenty seven organic compounds/group of compounds), and requires the companies that discharge these chemicals to prepare and submit a detailed pollution prevention plan every six years as well as a P2 plan summary every two years[15]. Nonetheless, there are no mandatory provisions for the implementation of the P2 plans, presumably because the City lacks the resources to fully enforce implementation. However, one may argue that since the imposed by-law limits are enforceable, they may remain as important drivers for companies to plan and implement pollution prevention strategies in order to reduce or eliminate the discharge of toxic metals and organic chemicals into the municipal sewer system.

In light of the above discussion, it is evident that despite the P2 planning provisions in CEPA (1999) and Toronto's Sewer By-law, there are no mandatory requirements for companies ***to implement*** pollution prevention strategies outlined in their P2 plans. In other words, implementation of P2 programs is still voluntary -- presumably because it calls for a change in the way businesses design their products and operate their manufacturing processes. Since there is flexibility allowed by the regulators to arrive at the pollution prevention goals defined in their P2 plans, the pollution prevention practices may vary from business to business. As suggested by Illomaki & Melanen (2001), enterprises in the same sector, under the same external pressures, may come up with different solutions to cope with their environmental challenges.

[13] Ontario Ministry of the Environment's Home Page: Retrieved on November 11, 2003 from the World Wide Web: http://www.ene.gov.on.ca/envision/coopagreements/launch.htm
[14] City of Toronto Sewer By-Law No. 457-2000 (amended July 6, 2000)
[15] In this case, the planning provisions are mandatory, and plans have to be submitted to the commissioner for approval

3.0 Pollution Prevention Practices in the Metal Finishing Sector

In general, the metal working industry serves the functions of shaping metals into useful products and parts for manufacturing. The metals are shaped, formed, drilled, and cast into appropriate shapes according to their intended use. In most cases, the metal parts produced are supplied to other assembly industries including appliance, automotive, defense, electronics, and furniture manufacturing (Guyer, 1998). However, after they are shaped and before they are ready for their intended application, most metals are finished to enhance properties such as corrosion protection and durability.

The two main industrial metal finishing operations are surface preparation, and metal finishing. Metal surfaces require preparation (cleaning/degreasing) prior to applying a finish in order to remove all foreign materials from the metal surfaces such as grease, loose dust particles, rust, or paint (Guyer, 1998). The common methods used in surface preparation are solvent cleaning (organic solvents used such as trichloroethylene, TCE), aqueous cleaning (e.g. acids, alkalis), the use of surfactants (e.g. sulfuric acid, alkali hydroxides and carbonates), and mechanical stripping to remove surface coatings.

Metal finishing usually involves a combination of metal deposition and numerous finishing operations including:

- **Anodizing** – an electrolytic process which converts the surface of metal e.g. Aluminum into an insoluble oxide coating
- **Chemical conversion coating** – process including chromating, phosphating, and metal coloring operations whereby the coatings are produced on various metals by chemical or electrochemical treatment. For example, phosphate coatings are formed by immersion of steel, iron and zinc plated steel in a solution of phosphate salts, phosphoric acid, and other reagents to condition the surfaces for further processing.
- **Electroplating** – production of a surface coating of one metal upon another by electrodeposition. The metal ions in acid, alkaline, or neutral solutions are reduced on the workpieces being plated. The metal ions in the solution are replenished by the dissolution of metal from solid metal anodes fabricated of the same metal being plated, or by direct replenishment of the solution with metal salt or oxides.
- **Painting** - involves the application of organic coatings to a workpiece for protective and/or decorative purposes. It is applied in various forms, including dry powder, solvent-diluted formulations, and water-borne formulations. Various methods of application are used, the most common being spray painting and electrodeposition.

3.1 Waste Generation and Pollution Prevention Opportunities in the Metal Finishing Sector

Wastes typically generated during metal finishing operations are associated with solvents and cleaners applied during surface preparation, and the metal-ion-bearing aqueous solutions used in the plating tanks. The cleaning solutions (e.g. acids) may appear in process wastewater; the solvents may be emitted into air (e.g. evaporation of volatile organic compounds (VOCs) from solvent degreasing process), or disposed of in solid form. In addition, aqueous wastes generated during surface preparation activities include solvent contaminated waste from vapor degreaser-water separators, rinse waters, and spent aqueous solutions (U.S. EPA, 1995; Bishop, 2000). Other wastes may include liquid waste solvent containing organic contaminants, waste water treatment sludges, still bottoms, cleaning tank residues, stripping debris, and contaminated abrasives. The metal bearing aqueous solutions commonly used may contain heavy metals such as hexavalent chrome, trivalent chrome, copper, gold, silver, cadmium, zinc and nickel, and depending on the nature of the coating underlying the metal, the waste generated may be toxic.

3.2 Pollution Prevention Opportunities for the Metal Finishing Processes

Metal finishing firms have significant opportunities to implement pollution prevention practices. Product or process changes can markedly eliminate or reduce toxics in air emissions and wastewaters generated while improving worker safety and cutting back on wastewater treatment and disposal requirements. The following pollution prevention strategies may be implemented to reduce/eliminate pollutants/waste in the metal finishing industry.

3.2.1 Source Reduction - Process Changes

Process changes are generally the most effective and cost-efficient modes of attack in the pollution prevention arena (Bishop, 2000). As described earlier, such modifications may include adopting more advanced process technologies, switching to less polluting reagents, changing the cleaning processes and chemicals, segregating waste streams, and improving the operating and maintenance procedures. Examples of process modifications related to metal finishers will be briefly described below under respective categories.

❖ **Technological Changes**

Improving the efficiency of a production process can significantly reduce pollutants/waste generation at the source. Process modifications such as automation or purchase of an efficient technology may reduce waste management and labor costs, but require the initial capital outlay for equipment changes and purchases. Some examples under this category include (U.S. EPA, 1994; Dupont *et al.*, 2000; Bishop, 2000):

- Air emissions from the vapor degreasing equipment can be reduced by increasing the freeboard height above the vapor level; covering the degreasing unit; rotating parts before removal to allow all condensed solvent to return to degreasing unit; controlling the removal rate so as not to disturb the vapor line.
- Increasing the rinse efficiency by using de-mineralized water, and keeping the rinsing counter current.
- Reducing rinse contamination via drag-out by: slowing and smoothing the removal of parts (rotating or slanting them if necessary); maximizing drip time; using drainage boards to direct dripping solutions back to process tanks; introducing drag-out recovery tanks to capture the dripping solutions; using techniques such as air knives to wipe the bath solutions from the metal parts; and changing bath temperature or concentrations to reduce the solution surface tension

❖ **Raw Material Substitution**

Often, decreasing the amount of pollutants/waste generated at the source can be as simple as selecting alternative materials for use in the process. Using this approach, the existing raw materials are replaced with materials that are less toxic or non-toxic to avoid or reduce the generation of pollutants/waste at the source (Bishop, 2000). Examples include:

- Substituting alkali washes for solvent degreasers
- Using less toxic acid and alkaline compounds in aqueous cleaning operations
- Using less hazardous degreasing agents such as petroleum solvents or alkali washes. For example, replacing halogenated solvents e.g. trichloroethylene (TCE) with liquid alkali cleaners

❖ **Best Management Practices: Improved Operating Practices**

A well-conceived and functional preventive maintenance program, proper employee training, supervision, and good housekeeping practices are all critical factors for building a successful P2 program (Dupont *et al.*, 2000). As in other industries, good operating practices are the easiest and often cheapest means of reducing waste in the metal finishing industry. Common practices include (Dupont *et al.*, 2000):

⇨ **Improved scheduling and planning of production:** Production planning and sequencing ensures that only necessary operations are performed and that no operation is needlessly reversed by a subsequent one. In addition, it may also eliminate unnecessary cleaning steps.

- ⇨ **Loss Prevention and Housekeeping Practices:** Preventive maintenance, as well as equipment and materials management enables firms to reduce opportunities for spills, leaks, evaporative losses, cross-contamination, and releases of potentially toxic chemicals (Guyer, 1998). These measures not only reduce waste disposal costs but enables the firm to keep process equipment in good condition through repair and replacement of leaky pipes and pumps, and minimize waste generated through loss prevention practices. Procedures such as using drip pans to recover leaking fluid also aid in recycling fluids in use and re-using them. Special attention should be paid to keeping the work areas clean in order to minimize product and equipment contamination.
- ⇨ **Waste segregation and separation**: Practices such as waste segregation and separation avoid the mixture of different types of wastes and the mixture of toxic and non-toxic wastes. These measures further facilitate recycling, reuse and resale for unavoidable wastes. Examples include: Segregating metal scrap by metal type; avoiding water contamination with different solvent waste streams (by keeping them segregated)
- ⇨ **Training and supervision:** These activities provide important production information to workers, necessary to reduce/eliminate waste/pollutant generation in their daily duties. The information provided makes employees aware of their role in daily operations, feeling responsible for their actions. Usually management ensures that workers are aware of, understand, and support the company's pollution prevention goals. It is also important to train them in the proper and efficient use of tools and supplies, which may also prevent accidents and health and safety risks associated with harmful chemicals.

3.2.2 Product Changes

One of the more effective ways to reduce pollution at the source is to make changes in the product itself or in the input materials used to make the product. For example, the plating technology allows for the elimination of much of the cyanide that was required in cadmium plating baths. Water-based paints have also replaced many of solvent-based paints. Metal workpieces with fewer turnings/cavities will reduce the amount of dragout from the process tanks (Dupont *et al*., 2000; Bishop, 2000). Examples related to the metal finishing industry include:

- Switching from Cadmium plating to Zinc Plating, eliminating use of cadmium entirely from the plating process
- Switching to a non-cyanide zinc plating process, where cyanide can be eliminated entirely from the plating process
- Switching from hexavalent chromium to trivalent chromium plating.

3.2.3 Resource Recovery (Reuse) and In-Process or Closed-loop Recycling

Closed-loop recycling is the on-site use or reuse of a waste as an ingredient or feedstock in the production process (Guyer, 1998). The metal finishing industry utilizes numerous recovery and recycling techniques to return a portion or all of the process chemicals to the original plating bath. However, a typical metal finisher should first evaluate the effectiveness of rinsing; determine if a viable, less polluting or nonpolluting substitute exists; and make those changes before investing in recovery and recycling equipment.

Recovery involves direct reuse without further processing, while recycled chemicals are used or reused in other industrial processes, or used as substitutes for other chemicals. Some of the operations commonly employed are:

- Reuse of concentrated rinse water in the electroplating process baths
- Recovery of metal or metal concentrates
- Recycling of treated wastewater
- Regeneration and reuse of process solutions

Having reviewed P2 practices applicable to the Metal Finishing Sector, it is clear that a wide range of opportunities exists with regards to pollution prevention in this sector. The following section will review the application of some of these methods to prevent pollution by participating SMEs in real-life scenarios.

However, what is interesting is not only to examine methods implemented by SME metal finishers, but also to gain insights into the incentives that led them to implement these methods, and examine their perceived benefits and challenges of implementing P2 practices.

4.0 POLLUTION PREVENTION IN SMEs - Introduction to the Research Study

Companies large and small alike are increasingly under pressure for improved environmental performance. For example, the recent incorporation of pollution prevention provisions into environmental legislation such as the *Canadian Environmental Protection Act* (CEPA) of 1999 and in Toronto's *Sewer By-law* (March 2000) are leading companies both large and small to work towards developing and implementing pollution prevention strategies. While these regulatory approaches act as positive forces towards adapting greener processes, they often trigger negative effects because they are not designed specifically for the small and medium business community (Canadian Federation of Independent Business (CFIB), 2002). Given their specific characteristics, the SMEs may cope with these external pressures very differently. In particular, the SMEs are limited in their capabilities to excel in environmental performance due to their limited financial, technical, and human resource capabilities to implement adequate environmental measures (Bianchi & Roci, 1998; Chiu *et al*., 1999). These challenges may make it difficult for an ordinary SME to implement sophisticated pollution prevention methods.

4.1 Objectives of the Study

In order to respond to the challenge of pollution prevention within SMEs, this study was geared towards analyzing pollution prevention practices incorporated by four SMEs in the Metal Finishing Sector, while reflecting upon their strategies and experiences. The main objectives were to gain insights into why and how the concept of pollution prevention is embraced by SMEs in the same industry. Since most of the pro-active programs for environmental management are often initiated by large corporations, a wide range of examples cited in the literature also reflect their ideas, experiences, and strategies. The techniques and tools used by SMEs may vary from those of larger corporations (Epstein & Roy, 2000). Very often, SMEs do not get a chance to express their opinions and viewpoints. Hence, this study attempted to get the viewpoints of SMEs themselves on the challenges and benefits they encountered during implementation of P2 practices while exploring their motives for initiating proactive measures.

4.2 Why the Metal Finishing Industry?

Since SMEs were the focus of this study, the metal finishing sector was a perfect example since 90% of the firms in this sector have fewer than 100 employees. The metal finishing industries constitute an important and environmentally sensitive industrial sector in Canada where there are six hundred and fifty "job shops"[16], mostly SMEs that produce $ 3.5 billion in annual revenue. Ontario alone is home to four hundred and fifty of these "job shops", employing roughly 15,000 people and generating $2.5 billion in annual revenue (Task Force of the Metal Finishing Industry Pollution Prevention Project, 2001a). Under the Standard Industrial Classification Codes (SIC codes), the metal finishers fall under the larger Fabricated Metal Products group (Major Group 34) which includes all establishments primarily engaged in all types of electroplating, plating, anodizing, painting, and finishing of metals and formed products for trade (Code 3471).

A recent study performed by OCETA (2002) analyzed 912 Ontario SME manufacturers that reported to NPRI[17] and found that of the 139 facilities that fell under the Fabricated Metal Products Industries category, 133 of them were in fact SMEs (i.e. app. 96%), and that 96% of the total pollutant loadings in this sector were contributed by these SME facilities (OCETA, 2002). Lately, this sector has been under growing scrutiny from regulators and the public, mainly due to its use and generation of an ever-increasing quantity and toxicity of pollutants/waste which cause cross media impacts to the environment (air, water, and land). However, it is also important to note that it is an essential industry in that all other industries require metal finishing in one form or another – this is particularly true of the automotive industry which is the driving engine of Ontario and Canada's economy. Therefore, this sector was

[16] Job shops provide a service, taking parts manufactured by others and electroplating/plating them with a combination of metallic coatings. These shops are typically very small businesses owned by families.
[17] NPRI data analyzed from the year 2000 (in Ontario).

selected because of its capacity to benefit from pollution prevention due to its adverse impacts on our health and environment, and its importance to the Canadian economy.

4.3 Research Method

A qualitative research study was designed for the participating SMEs using two main techniques of investigation: an inquiry Questionnaire, followed by the conduction of semi-structured interviews. The following criteria were used to select participating firms:

- Metal finishers that fall under the SME category (<500 employees) with facilities within the Greater Toronto Area (GTA) -- as the study was limited to the local level.

Initially a number of metal finishing companies were contacted via telephone and screened to meet the criteria outlined above[18]. Seven SME metal finishers were identified on the basis of the criteria above. The Environmental Managers (or persons responsible for the environmental matters) of these SMEs were contacted by telephone, informed about the research project, and requested to participate in this study. Out of seven companies contacted, only four Environmental Managers (or persons responsible for the environmental matters) agreed to participate in the study. Upon verbal agreement, a written informed consent was drafted and mailed to respective participants in order to notify them of the nature of the study prior to beginning the research work. Participants were reassured of the confidentiality maintained for all proprietary information or trade secrets related to a competitive business enterprise. The participants were given some time to review the informed consent and sign it to record their final approval of participation.

A generic survey Questionnaire designed for the purposes of this study was emailed to the respective SME Environmental Managers (or persons responsible for the environmental matters) in June 2002 to collect qualitative information (Appendix A). The companies were requested to electronically mail back the completed Questionnaire within a month's time. The questions were divided into three main parts and covered inquiries in the following areas:

PART 1: Environmental Activities and Commitment within an Organization

a. An existing Environmental Leadership team or Green Team
b. An inquiry into firm's existing Environmental Policy or Plan with commitment towards P2.
c. The organization's motives towards improving its environmental performance
d. An existing EMS (such as ISO 14001) in place.

PART 2: Pollution Prevention Practices in SMEs

e. Use of the P2 Planning process to develop P2 plans
f. Current and future use of P2 methods (source reduction/in-process recycling) used to reduce/eliminate their pollutants/waste streams
g. Results in reducing/eliminating targeted pollutants/waste streams
h. Cost savings related to P2 measures
i. Factors or motives that led the firms to implement P2 methods and integrate P2 within their business plans
j. Management practices in the firm

PART 3: Benefits and Challenges of Implementing Pollution Prevention Measures

k. Benefits enjoyed by the firm from implementing the P2 strategies
l. Challenges faced by the firm while implementing P2 strategies

All four SME participants responded within the timeframe provided. The information from the Questionnaire was reviewed and organized. Each of the SME representatives was then invited to

[18] The companies were identified from a list of names published in the Metal Finishing Industry Pollution Prevention Project Progress Report (2001). The companies were signatories to this Project (under MOU). Mr. Fred Granek – the External Supervisor for Major Paper – also referred one small company for the study.

participate in an individual interview session, conducted on their firm's premises. The interviews were carried out in July and August of 2002. The conversations held during these sessions were audio taped or recorded and transcribed.

The interviews reviewed the same set of questions as the Questionnaire, thus maintaining the same theme. However, the interviews included additional open-ended questions. The interviews were conducted with the intent to obtain further elaboration on answers provided in the survey, obtain missing information, and collect in-depth data (of a qualitative nature) with respect to the survey Questionnaire. The interviews were also conducted to get a clear detailed view of the company representatives themselves to account for their personal experiences during the course of implementing P2 practices. In some cases, additional written material was collected (process descriptions, procedures) from company personnel. The information collected from the Questionnaires and the semi-structured interviews is summarized and analyzed in the following section.

5.0 Qualitative Analysis of SMEs in their Efforts towards Pollution Prevention (P2)

5.1 Background of the Research Study

Through a qualitative analysis, this chapter will attempt to review the pollution prevention practices embraced by four SMEs in the Metal Finishing Industry. The analysis will uncover some of the benefits and challenges as seen by the management of the firm with regards to successfully integrating P2 into their business strategy. As previously mentioned, the research firms in this study collectively fall under the SME category but may be individually compared according to their sizes. In such a case, business having fewer than 50 employees will fall under the "small" business category, while those having 51-500 employees will fall under "medium"[19].

As mentioned in Section 4.0, the data compiled for the analysis were gathered through a Questionnaire provided to all four participating SMEs, along with semi-structured interviews with the company representatives. The information collected from the Questionnaire and the semi-structured interviews is summarized and analyzed in the sections below.

Prior to making inquiries through the Questionnaire, the participants were asked to provide information on their roles in the company, the size of their company, and the total number of employees employed at their facilities. Their responses have been summarized in Table 1.

It was not necessary for the participants to identify themselves for the purpose of this study; hence the names of the participating firms, including the identity of company representatives, will remain anonymous. Instead, pseudonyms will be used to refer to the participating SMEs throughout this document. A summary of each participating SME is presented below.

RESEARCH FIRM #1 (SME1) – Smallest Firm in Size
This family owned firm is a metal plating facility in Toronto that manufactures miscellaneous metal products including fireplace inserts and screens, woodburning stoves, fireplace tools, and airport weight scales. Three main processes that take place at the facility are degreasing, plating, and painting. Most of the plating work at SME1 is performed for in-house use (to produce their final product), as they do not plate parts for other clients.

RESEARCH FIRM #2 (SME2)
SME2 is also a family owned small job shop, which offers decorative electroplated finishes to the lighting, furniture, and store fixture markets. The main operations taking place at this facility include: abrasive belting (cleaning), vapor degreasing (cleaning), plating, and spray lacquer coating. There are no fabrication or manufacturing processes occurring at this plant facility; only surface finishing services are provided to designated clients. The parts and components from clients are polished, plated, top coated, and returned to the clients.

RESEARCH FIRM # 3 (SME3)
SME3 is a job shop whose production focuses on zinc plating and phosphating of automotive parts, electrical components, and fasteners. The Toronto-based facility processes approximately 150 tons of products per day. SME3 is currently ISO 9002 and QS 9000 Certified and is working towards the ISO 14001 Certification.

RESEARCH FIRM # 4 (SME4) – Largest Firm in Size
SME4 is one of the leading fabricators of printed circuit boards in the North American and European markets, with two manufacturing locations in Toronto. The printed circuit boards are produced through many processes, including plating and surface finishing. SME4 has certified to the ISO 9000 and ISO 14001 Standards. In fact, it is among the first North American printed circuit board manufacturers to attain the ISO 14001 registration. SME4 has even received a silver medal in "Environmentally

[19] This classification matches that of Statistics Canada and Canadian Federation of Independent Business (CFIB).

Sustainable Business Awards." This award recognizes businesses that have demonstrated a commitment to environmental protection by reducing resource and energy requirements, waste materials, and air and water pollution.

Table 1: List of Participating SMEs and Related Information

Research Firm # (Location)	Type of Work	# of Employees	Total # of Facilities Owned by the Firm	Business Category	Contact Personnel (Interviewee)
SME1 (Toronto) *Family Owned* *(smallest research firm)*	Job Shop - Metal Plating of Fireplace Accessories Airport weight scales	15	1	Small (SME)	Production Manager (family owned business)
SME2 (Toronto) *Family Owned*	Job Shop - Plating of lighting furniture and store fixtures	35	1	Small (SME)	Technical Manager (family owned business)
SME3 (Toronto)	Job Shop – Zinc Plating of Automotive parts	71	1	Medium (SME)	Quality Assurance/ Environmental Manager/ Chair for the Canadian Association of Metal Finishers (CAMF)
SME4 (Toronto) *(largest research firm)*	Fabricators of Printed Circuit Boards	350	3	Medium (SME)	Environmental Health & Safety Manager

5.2 Questionnaire and Interview Session Analysis

The questions from the Questionnaire and interview sessions consisted of inquiries in three main parts. Each of these questions will be analyzed individually. For each question asked, the analysis will explain why the question was asked (or its intent), and what the actual responses were based on the information provided by the SME representatives in the Questionnaire and the interview sessions. Major findings will be presented and discussed at the end of each question asked. Furthermore, a concluding discussion of the study with recommendations will be discussed in the final chapter. Since the responses to the Questionnaire and interview sessions were provided by company personnel (the interviewee), many of these responses actually reflect their personal views, and not necessarily those of the company.

5.2.1 PART 1: Environmental Activities and Commitment within an Organization

In general, the questions in this part are intended to familiarize the reader with the environmental initiatives undertaken by each SME, which reflect commitment from their leadership. Prior to asking these questions, the participants were given an opportunity to introduce themselves and provide some idea of their individual roles in the company.

Question 1

Please describe who takes care of the environmental matters at your facility, i.e. Environmental Managers, Coordinators, Health and Safety Managers, Production Manager etc. If you have an existing environmental department or Green Team at your firm, please describe its structure.

Intent of the Question

An important sign of leadership and management commitment in a firm is the establishment of positions such as Environmental Director/Manager/Officer, which form a firm's Environmental Department with the responsibility of handling environmental matters of the firm, e.g. compliance with laws and regulations and implementation of environmental policies developed by a firm (Freeman, 1995). A recent survey in the U.K (NetRegs Benchmarking Survey, 2002) revealed that most SMEs appoint a staff member to take responsibility for environmental issues in their firm. Hence, this question was asked to get a general idea of any such appointments within SMEs, which would then reflect their leadership commitment towards environmental protection in the firm.

Response and Discussion

The general atmosphere in the interviews was very positive. The small firms in this study were owner-managed companies employing a relatively small number of employees in comparison with the other two medium-sized firms. Each of these firms took responsibility for handling environmental matters in their firms, with at least one staff member appointed to take full responsibility for coordinating their environmental affairs. Interestingly, the larger job shops such as SME3 and SME4 had structured environmental departments with knowledgeable staff trained and designated to handle various environmental issues. In fact, their environmental, health and safety activities were integrated in one department under a common leadership team. However, the production manager of SME1 -- the smallest research firm -- handled the responsibility for coordinating all environmental issues, in addition to production control. Although this position may be a burden given his regular duties as production manager, his experience in working with the production process on an everyday basis may enable him to come up with some practical, straight forward suggestions for dealing with the company's environmental problems.

A summary of responses to questions 1- 4 is presented in Table 2.

Question 2

Does the company have an environmental policy, which includes commitment for pollution prevention (P2)? If yes, is it possible to get a copy of this policy?

Intent of the Question
Developing an environmental policy has been identified as an important sign of environmental commitment or a sign of the initiation of an environmental program with commitment to pollution prevention (Roy *et al.,* 2001). Such policies make a company's environmental values more apparent. This question was asked with the intent of knowing if the firm had a written Environmental Policy document that declared a firm's goals and vision towards protecting the environment and preventing pollution. Research in China's Electroplating Industry (Warren & Ortolano, 1998) showed that firms practicing a high degree of pollution prevention had a proactive approach to prevent pollution and thus declared pollution prevention as their preferred environmental management strategy.

Response and Discussion
In general, all the participating research firms had developed written environmental policies, which declared their commitment towards the protection of the environment, using pollution prevention as the preferred environmental management approach. Copies of the policies provided during the interview sessions were obtained directly from their P2 Plan document.
A summary of responses to questions 1-4 is presented in Table 2.

Question 3
Does your firm have an Environmental Management System (EMS) such as the ISO 14001 Standard, in place? If yes, is P2 incorporated into the EMS or did you construct your P2 plan within an existing EMS? If no, did you start your P2 plan from scratch? (Please record other guidance documents/resources you utilized while constructing your P2 plans).
Intent of the Question

An existing EMS in place reflects corporate responsibility to minimize its environmental impacts by integrating environmental concerns into the existing management systems (Roy, Boiral, & Lagace, 2001). It has been reported that large businesses are more likely to have an EMS, while small businesses are far less likely to even be planning to introduce EMS in the future (NetRegs Benchmarking Survey, 2002). This question was asked to inquire if any of these SMEs had developed an EMS, or if they intended to build one in the future, and if it provided a means of integrating their P2 component and developing their P2 plans.

Response and Discussion
An inquiry regarding the existence of an EMS – ISO 14001 Standard revealed that two out of four companies did not have the standard in place, and started their pollution prevention plans from scratch, to fulfill the P2 planning requirements of Toronto's Sewer By-law. As anticipated, the largest firm in this study (SME4) had developed and implemented an EMS ISO 14001 Standard, with an integrated P2 component that also assisted them with the construction of their P2 plan. The Environmental Manager of SME3 reported that their effort towards the development of the Standard was in progress. The Production Manager of SME1 (the smallest SME) expressed his interests in developing an EMS (probably as an act of due diligence), but remained hesitant about certification mainly due to the high costs of registration and copious paperwork involved. The Technical Manager of SME2 noted that they had no intention to develop an EMS, as there were no general requirements of ISO certification from their clients.
A summary of responses to questions 1-4 is presented in Table 2.

Question 4
What is the organization's main motive/trigger to improve its environmental performance?

Intent of the Question
The intention of this question was to get a sense if there was a genuine desire to protect the environment among participants. An environmental survey conducted by CFIB in September 2000 (Dulipovici, 2001) revealed that SME owners are genuinely concerned about protecting the environment, and that the beliefs and views of employers and employees are the driving force behind their progress.

Response and Discussion
The responses to this question have been summarized in Table 2. The majority of the answers from SME representatives were geared towards setting industry precedents, while keeping up-to-date with the

environmental regulations. Their responses mainly implied that pressure from external stakeholders (e.g. regulators, competitors) played an important role for them to improve their environmental performance. Interestingly, none of the participants directly mentioned the desire to protect our natural environment, at least not in this open-ended question format. However, one small business owner expressed concern about reducing waste and harmful pollutants and proper disposal of pollutants/waste. These factors will be further discussed in Part 2 of this chapter.

A summary of responses to questions 1-4 is presented in Table 2.

Table 2: Summary of Responses to PART 1: Environmental Activities and Commitment within an Organization

Research Firm #	Person Responsible for Environmental Matters (Environmental Department?)	Does Company have Environmental Policy? Does it Include P2 commitment?	Does Company have an EMS – ISO14001 Standard? P2 Plan integrated with EMS?	Main motives for Improved Environmental Performance?
SME1 *Family Owned* *Smallest Research Firm*	Production Manager No Green team/Environmental Dept. (Production Manager reports to his father - the owner)	YES YES	NO P2 Plans written from scratch (for City of Toronto)	- Proper waste disposal - Reduce waste & harmful pollutants - Get employees' input on preventing emissions (sic)
SME2 *Family Owned*	Technical Manager Joint Health and Safety Committee (4 members - also trained to handle environmental matters) Technical Manager reports to his father	YES YES	NO P2 Plans written from scratch (for City of Toronto)	- Staying ahead of changing environmental regulations - Develop better relations with regulators -Leadership in industry
SME3	Quality Assurance/Environmental Manager & Health and Safety Manager Company has existing Environmental Committee & Joint Health and Safety Committee	YES YES	Development of ISO 14001 in progress P2 Plan for City of Toronto integrated with EMS component Reg. Intended by DEC 2002	- Compliance with regulations - Go beyond compliance (P2 and economic Benefits) - Improve corporate image & leadership in industry
SME4 *Largest Research Firm*	Environmental Health & Safety Manager Existing Environmental Department -- Environmental Health & Safety Manager And 5 waste treatment Technicians.	YES YES	YES - ISO 14001 Registered EMS P2 Plan for City of Toronto Integrated with EMS component	-Environmental responsibility & leadership in industry - Satisfy stakeholder needs

COMPANY SIZE INCREASES

5.2.2 PART 2: Pollution Prevention Practices in SMEs

The questions in this part constitute an inquiry into pollution prevention practices incorporated by the SMEs: the pollution prevention methods employed, and tools used (e.g. P2 planning process) under the influence of management practices that enhance the internalization of P2.

General Questions Asked, the Responses & Discussion

Prior to asking Part 2 questions during the interviews, the SME representatives were asked to indicate their participation in past or current voluntary pollution prevention initiatives. All the SMEs except SME1 (smallest firm) had actively participated in a voluntary P2 program -- The Metal Finishing Pollution Prevention Project (Ontario)[20]. This joint government-industry project operates under a Memoranda of Understanding (MOU) between the Canadian Association of Metal Finishers (CAMF), the American Electroplaters and Surface Finishers Society (AESF), the Metal Finishing Suppliers' Association (MFSA), the Ontario Ministry of the Environment (MOE), and Environment Canada[21](Task Force for the Metal Finishing Pollution Prevention Project, 2001b). It is aimed at assisting the metal finishing industry with the implementation of pollution prevention practices and to demonstrate their benefits to the environment[22]. The responses to this question revealed that three out of four participating SMEs had substantial experience in implementing pollution prevention practices, prior to the incorporation of pollution prevention provisions in the revised CEPA and Toronto's Sewer By-law. According to the Production Manager for SME1, they were 'part of' or members of CAMF, but had just not maintained close networking with their industry association, thus failing to benefit from consultation with other members of the metal finishing firms. However, it is important to note that the Production Manager for SME1 was a member of the Emery Creek Environmental Association – a local community environmental awareness group – that encourages voluntary participation in environmental activities including pollution prevention within the Emery Creek Watershed[23].

At some point during the interview sessions, all the interviewees were asked to define pollution prevention in their own words, or provide a favorite definition if they had one. The intent was to know if the interviewees were aware of the general distinction between P2 and pollution control measures. It has been argued that many of the small business operators who have generally never installed control or treatment equipment may not have their minds set on the subject of pollution prevention anyway (P2SBWG, 2000).

Most of the participants were generally aware of the distinction between pollution prevention and pollution control measures, although one small business owner explained pollution prevention as including end-of-the-pipe treatments. Three interviewees referred to the definition provided in the City of Toronto's Sewer By-law[24], but did not seem to respond enthusiastically to the use of this definition in the regulation. One individual argued that the official (or legal) definition of P2 was rather restrictive and impractical, as it failed to recognize their efforts to re-use input materials either on-site or off-site. Another individual argued that the classical P2 definition does not apply to metal finishers (who use metals, which may be pollutants) due to a contradiction of terms used in the definition, i.e. "reduction and elimination of pollutants at the source." He explained that since they use metals, use of any such terms in the definition

[20] During the Interview Session (July 2002), the Environmental Manager for SME3 – who is also Chair for the Canadian Association of Metal Finishers (CAMF), indicated that the MOU agreement for this project had expired. According to him, the CAMF was hesitant to formally commit to voluntary participation especially after mandatory incorporation of P2 in Toronto's Sewer By-Law. However, the Chair noted that the signatory companies still meet – even without a formal agreement.

[21] Participating companies first became signatories to this project in 1993, guided by principles set out in the MOU. Hence, this program was initiated prior to the incorporation of P2 into revised CEPA (1999) and Toronto's Sewer By-Law

[22] The Canadian Association of Metal Finishers – Ontario Compliance Assistance Program (ONCAP) Home Page, retrieved November 9, 2003 from the World Wide Web: http://www.oncap.ca/p2assistance

[23] This association is a business to business network dedicated to reducing source pollution within the Emery Creek Watershed. In fact, this non-profit organization had committed to a former co-operative agreement between the former Ontario Ministry of Environment and Energy, and Environment Canada, among other partners including local businesses to reduce wastes at the source of the Emery Creek Watershed. [Emery Creek Environmental Association Home Page, retrieved November 11, 2003 from the World Wide Web: http://home.interlog.com/~emery/]

[24] i.e. "use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants or waste, at the source" (Toronto Sewer By-Law (2000) Section 1 – Definitions)

would literally mean that they would have to go 'metal free' and ultimately terminate their businesses. The individuals also noted that the closed-loop recycling processes were not feasible at every stage of their production, and that it was rather difficult for them to obtain the appropriate technology.

Question 5

Did you utilize the P2 planning process as a main method used to promote P2 within your organization, and develop a P2 Plan? If yes, please answer the questions below:

a. **Did you hire any professional consultants to help you with the planning process? If not, did the company employees seek assistance elsewhere?**
b. **How long did the planning process take?**
c. **How many options were implemented (or which options were implemented from the total options generated during the planning stage)?**

Intent of the Question

This question intended to discover how the research firms went about identifying and addressing their pollution prevention opportunities. It was expected that most firms would utilize the planning process to develop their P2 Plans. It was hoped that the SMEs would highlight some of their experiences in adopting the planning process and reveal any professional assistance they required to develop their P2 plans.

Response and Discussion

A telephone conversation[25] with City of Toronto Official Mr. Vic Lim revealed that all metal finishers in the City of Toronto were required to submit their P2 Plans by June 1st 2001 (in accordance with the City of Toronto Sewer Use By-law). City officials had been expecting a total of 108 plans from this sector. However, five companies in this sector failed to deliver their P2 plans. Of the 103 plans received, city officials rejected only six. 97 plans were approved from the Metal Finishing Sector.

All four interviewees reported that they had prepared and submitted their P2 plans in accordance with the requirements of the City of Toronto Sewer Use By-law No. 457-2000, and had received acknowledgement of their approval. However, none of the SMEs had prepared or submitted a P2 Plan to fulfill the CEPA (1999) requirements -- presumably because the majority of CEPA's P2 planning provisions have not been used yet. In fact, the interviewees seemed unaware of the new CEPA (1999) P2 planning requirements.

All the SMEs had utilized the pollution prevention planning process to develop their P2 plans. The length of the planning process varied between three months (SME1) to one year (SME4), depending on the type of resources available to the companies. One small firm owner knowledgeably commented that their planning process is an on-going process, which has required continuous improvement for the last 20 years.

Interestingly, three out of four firms (SME1, SME3 and SME4) were able to hire environmental consultants to assist them with the development of P2 plans. In most cases, the consultants worked hand-in-hand with company employees to generate the P2 options, although the task of implementing the generated options was left to the companies' management. However, one small firm owner admitted that their consultant constructed their entire P2 plan that had to be submitted to City officials. His firm had participated in the Toronto Region Sustainability Program through OCETA, which provided a 50 percent subsidy of the costs for hiring a consultant to perform a P2 assessment. The two medium-sized SMEs that hired consultants did not receive assistance of this sort, as they were able to allocate funding for the hiring of a consulting team.

The Technical Manager for SME2 explained that they did not hire consultants largely to control costs, but also because they felt that they had the in-house expertise and knowledge to handle their own plan. Instead, he acquired assistance largely from networking with government officials (e.g. City of Toronto Representatives) and by keeping close contact with their industry association - CAMF.

[25] Held between Meenaz Hassanali (Researcher) and Vic Lim (City of Toronto) in October 2002.

From the conversations with SME representatives, it is gathered that the medium firms in this study attempted to involve their company employees (their respective environmental departments) to play significant roles in the gathering of data, the analysis of material flows, and in the generation of prevention options. Unfortunately, this was not sensed among the small firms in this study, particularly SME1. However, there is no doubt that most of the participants themselves got personally involved in the planning process, which according to them increased their knowledge of various production processes at the facility, resulting in a more planned approach to setting goals for reducing or eliminating their identified pollutants/waste streams.

The experiences of these four facilities suggest that the P2 planning process was highly time consuming and labor intensive. Clearly, not all the options identified during the planning phase were implemented. All the SMEs reported implementing P2 options at some point – with as many as four options already implemented in all firms, with some options underway. Options with a shorter payback period and low initial costs were implemented first. In practice, although the SMEs were successful in developing their P2 plans (and getting them approved by regulatory officials), these P2 plans were in fact not fully implemented -- presumably because implementation is not mandatory.

Question 6

Please outline the main processes conducted at your metal finishing facility, e.g. metal cutting, cleaning/de-greasing, plating, painting etc.

Intent of the Question

The intent of this question was to get a general understanding of the basic metal finishing operations occurring at the facility, which would in turn aid in identifying the waste/ pollutants resulting from these processes along with the applicable pollution prevention measures.

Response and Discussion

The majority of processes outlined by firms in response to this question included various metal plating and cleaning processes, previously discussed in Chapter 4. Refer to SME responses to Question 6 in Appendices D – G for more details.

Question 7

From the processes listed above, please choose one process (e.g. plating or de-greasing) and identify the main pollutants/waste stream generated from this process (e.g. plating or cleaning solution). For the purposes of this survey, you are kindly asked to provide information on pollution prevention initiatives on this particular substance. Hence, it is suggested that you choose the one on which significant pollution prevention efforts have been achieved.

Intent of the Question

This question was asked to give the participants an opportunity to identify a process operating at their facility, which generates substantial amount of pollutants/waste. The purpose of this question was to lead them to the next question which required them to provide information on any pollution prevention measures they had undertaken to reduce/eliminate the identified pollutants or waste stream.

Response and Discussion

For Questions 7 – 10, a summary of responses has been provided in Table 3, followed by a discussion section at the end.

Question 8

What specific P2 methods (i.e. source reduction methods) did you use to reduce/eliminate the pollutant/waste stream identified above?
For the purposes of this survey, please provide a description of the process chosen (Q.7) before P2 initiatives, along with the changes to this process after the implementation of the product/process changes. You can provide copies of any previous write-ups etc.

Intent of the Question
It has been suggested by Illomaki & Melanen (2001) that enterprises in the same sector, under the same external pressures may come up with different pollution prevention strategies to prevent subject pollutants/toxic substances. Essentially, this question was asked to review P2 methods implemented by SMEs in an attempt to reduce or eliminate target pollutants/waste streams at the source. It was hoped that this question would provide insights into the various choices made between process and product changes.

Response and Discussion
For Questions 7 – 10, a summary of responses has been provided in Table 3, followed by a discussion.

Question 9
Did this pollution prevention method, in your opinion, achieve the reductions expected? If there was a decrease in the use or generation of this pollutant/waste stream after implementing P2 strategy/or after modification, please quantify the results.

Intent of the Question
It was hoped that the participants would share the direct results of their implemented measure such as a reduction or elimination in use or generation of the identified pollutant/waste stream.

Response and Discussion
For Questions 7 – 10, a summary of responses has been provided in Table 3, followed by a discussion section.

Question 10
Did you save money and decrease production costs and waste management costs from implementing this method(s)? Please quantify the amount.

Intent of the Question
Perhaps the most attractive benefit of implementing P2 measures to business is the potential for cutting costs and saving money (Dipeso, 2000). It was hoped that the participating firms would share their cost savings related to the implementation of P2 methods.

Response and Discussion
For Questions 7 – 10, a summary of responses has been provided in Table 3, followed by a discussion section.

Table 3: Summary of Responses to PART 2: Pollution Prevention Practices in the Metal Finishing SMEs

Research Firm #	Process Chosen	Targeted Pollutant/Waste Stream	P2 Method Implemented	Reductions Achieved	Cost Savings
SME1	**Surface Preparation** (Cleaning/de-greasing) The vapor degreaser is used for all cleaning/ de-greasing processes at the facility	Reduce evaporative losses and the use of Trichloroethylene (TCE) TCE – organic contaminant found in vapor phase – a major environmental pollutant that poses significant risks to human health.	**SOURCE REDUCTION** **<u>Process Changes</u>** ***Technological Changes*** Air emissions containing TCE from the vapor degreasing equipment were reduced by modifying the tank configurations, such as increasing the freeboard height above the vapor level and covering the degreasing unit ***Improved Operating Practices*** The workers were trained and made aware of the harmful airborne TCE vapor. They practiced loss prevention and good housekeeping practices to reduce the evaporative losses of the air borne TCE vapor. Examples include covering the degreasing units, and stopping the part in the freeboard area to let the vapor settle down before continuing to raise the freeboard height. **[Implementation over last year]** **<u>In-Progress</u>** ***Raw Material Substitution*** Firm in the process of switching to a caustic bath for cleaning the parts in place of vapor degreaser.	These measures have not been implemented long enough to see any significant reductions. These changes have been put in effect since October 2001. However, it has been anticipated that these changes could reduce the evaporative losses of TCE by 35 % It is anticipated that this option would provide 50% reduction in the use of TCE	Production has increased, hence uncertain on cost savings. Have not calculated cost savings yet, but predicting about 10-15 % savings. The practices have been anticipated to save $1500/yr The caustic bath option is anticipated to save $2100/year.

Research Firm #	Process Chosen	Targeted Pollutant/Waste Stream	P2 Method Implemented	Reductions Achieved	Cost Savings
SME2	**Metal Plating Line** In all the Plating operations at the facility, metals are lost to the wastewater treatment systems due to dragged out chemistry from process baths	Recover and re-use copper, nickel, and zinc from the plating bath rinse waters and reduce the loadings of these metals to the wastewater treatment system. 20% Reduction in use of copper, nickel, and zinc. * Zinc was mainly an effluent from brass plating	**RESOURCE RECOVERY AND IN-PROCESS OR CLOSED-LOOP RECYCLING** ***Technological Changes*** The company installed three separate electrolytic metal recovery units on copper, nickel, and zinc plating rinse waters that recovered the lost materials into a form that was directly re-usable into the original process. **[Implemented over last 10 years]**	This option provided the double benefit of reducing the load on the wastewater treatment plant as well as reducing the need for purchasing virgin raw materials. The electrolytic recovery units recovered 600 kg/yr of copper and zinc, and 1100 kg/yr of the nickel metal. These metals were used directly in the plating process as anode material. The use of these systems had a very positive effect on the firm's ability to maintain an average of one half of the City's limit for sewer discharge of these materials.	The reduction of metals in rinse waters led to savings in the waste treatment system. Sludge disposal was reduced from 7 cubic meters of sludge per year to 7 cubic meters of sludge every 26 months. This resulted in disposal cost savings of $2500/yr. The waste treatment costs were reduced by $12,800/year and the company also reduced water consumption by $2880 per year. The savings realized by these changes provided a 2.5 years payback period for equipment costs
	Spray Lacquer Coating (top coating) (Option # 2)	25% reduction in lacquer and solvent use (thus reducing Volatile Organic Compound – VOC emissions) (lacquer materials are solvent based air dry acrylic finishes)	**SOURCE REDUCTION** **Process Changes** *Technological Changes* The company switched to High Velocity Low Pressure (HVLP) spray guns from their standard air atomized spray guns. **[Implemented over last 2 years]**	The HVLP guns reduced over spraying and improved fluid transfer efficiency, which resulted in a better work environment, with lower VOC emissions, 20% reduction in air dry acrylic lacquer in 1st year	Annual savings of $2500 with a payback period of less than one year.

Research Firm #	Process Chosen	Targeted Pollutant/Waste Stream	P2 Method Implemented	Reductions Achieved	Cost Savings
SME3	**Metal Plating Line**	Total Elimination of metals Cadmium and Cyanide from the plating operations.	**SOURCE REDUCTION** **Product Changes** The company eliminated plating operations, which used input materials such as cadmium and cyanide. (SME3 eliminated cadmium plating and got rid of the cyanide destruction operation.) <u>Instead, SME3 switched to zinc and chromium plating.</u> **[Implemented over last 10 – 15 years].**	100% reduction in Cadmium and Cyanide. These two metals were subject pollutants addressed in the City of Toronto Sewer By-law. The total elimination of these metals lessened the regulatory reporting requirement on SME3.	The sludge was now non-hazardous and disposed of in regular landfill. This led to disposal cost savings of up to $200,000 a year. In addition the cyanide destruction system operation costs were up to $100,000 a year. The elimination of this process led to cost savings of $100,000 a year. TOTAL SAVINGS = app. $300,000 per year
	Metal Plating Line Various zinc and chromate plating lines	Zinc and Chromium	**[Current P2 practices]** **<u>SOURCE REDUCTION</u>** **Process Changes** ***Technological Changes and Improved Operating Practices*** Extended life of cleaner baths, 25% drag-in/drag-out reduction, counter current flow rinsing with increased number of rinse baths. Improved plating bath operations – preventive maintenance to reduce opportunities for spills and leaks. Training and supervision for efficient use of equipments and in keeping work areas clean to prevent accidents.	Estimates not provided	Estimates not provided

Research Firm #	Process Chosen	Targeted Pollutant/Waste Stream	P2 Method Implemented	Reductions Achieved	Cost Savings
Continued….. SME3			**<u>In-Progress (1st year of Implementation)</u>** **(Implementation Plan = 3years)** **SOURCE REDUCTION** **Process Changes**		
		Zinc	***Technological Changes*** Installation of reverse osmosis units on each zinc chloride and zinc phosphating line	Possibility of approximately 80% reduction in use	Projected annual cost savings of > $100,000 with a payback period of 1.5 years
		Hexavalent-Chromium	**Product Changes** ***Input Material Changes*** Change product use from hexavalent chromium to trivalent chromium which will reduce chemical consumption	Anticipated approximately 50% reductions in hex-chrome	Projected annual cost savings of > $ 80,000 with a payback period of 0.1 years

Research Firm #	Process Chosen	Targeted Pollutant/Waste Stream	P2 Method Implemented	Reductions Achieved	Cost Savings
SME4 (City of Toronto, Works and Emergency Services Department assisted the company with this case study) * the case was available on SME4's website	**Metal Plating Line**	Reduction in generation of copper effluent & Reduction of copper concentration in plating bath solution	**SOURCE REDUCTION** **Process Changes** *Technological Changes* Programmable drip times Counterflow spray rinsing Continuous filtration *Improved Operating Practices* Inventory management, proper material handling (training), good housekeeping practices, and waste segregation **<u>In-Progress</u>** **SOURCE REDUCTION** **Process Changes** *Technological Changes* Installation of point source electrowin on static rinse tank downstream of electroless copper tank Reduction of the existing drag out copper concentration	Estimates not provided This option is anticipated to decrease current copper effluent by 97% This option is anticipated to reduce the existing drag out concentration of copper by 20%	Estimates not provided Projected annual net operating cost savings of $37,000 with a payback period of 1.24 years Projected annual net operating cost savings of $60,000 with a payback period of 0.42 years

Discussion of Questions 7 - 10

All four SMEs in this study had implemented pollution prevention measures to some extent. However, their pollution prevention methods and approaches varied as each firm exploited several source reduction techniques to target different pollutants/waste streams. The majority of the modifications resulted in process changes, as only one medium-sized firm (SME3) reported on implementing product changes. Among the common process changes implemented were the low-cost P2 options involving improved operating practices. SMEs relatively larger in size to SME1 had more technical expertise and experience in the field of pollution prevention, as they reported on implementing sophisticated technological changes, which took longer to be fully implemented. SME1 mainly reported implementing low cost P2 options involving improved operating practices and minor technological changes, which were implemented over the past year.

SME2 and SME3 initiated their first P2 efforts some 10 – 15 years ago, with some of the P2 options now fully implemented. These SMEs had achieved significant reductions in use and generation of targeted pollutants through implementation of various P2 methods. However, since some options were currently in progress, only the anticipated estimates were provided. Interestingly, the majority of the P2 methods incorporated by SMEs resulted in cost savings and had relatively short payback periods (<2.5 years). In many cases the disposal costs were also significantly reduced. For example, companies SME2 and SME3 reported significant operating and disposal cost savings, with relatively short payback periods. The data provided by SME4 only showed projected values. Similarly, the owner/manager for SME1 explained that they had not calculated cost savings from their current P2 operations, and the values provided were only the projected values calculated by their consultant.

Question 11

Prior to asking this question, some of the factors or motives that lead firms to implement pollution prevention methods were researched from the literature (reviewed in Chapter 1) and presented to the participants to grade on a scale from 1 to 5, where a score of 1 meant that they did not agree with the factor, while a score of 5 indicated their strong agreement.

Intent of the Question

The main purpose of this question was to let the participating research firms identify and discuss the key factors or motivators that influenced their decision to implement P2 methods.

Results and Discussion

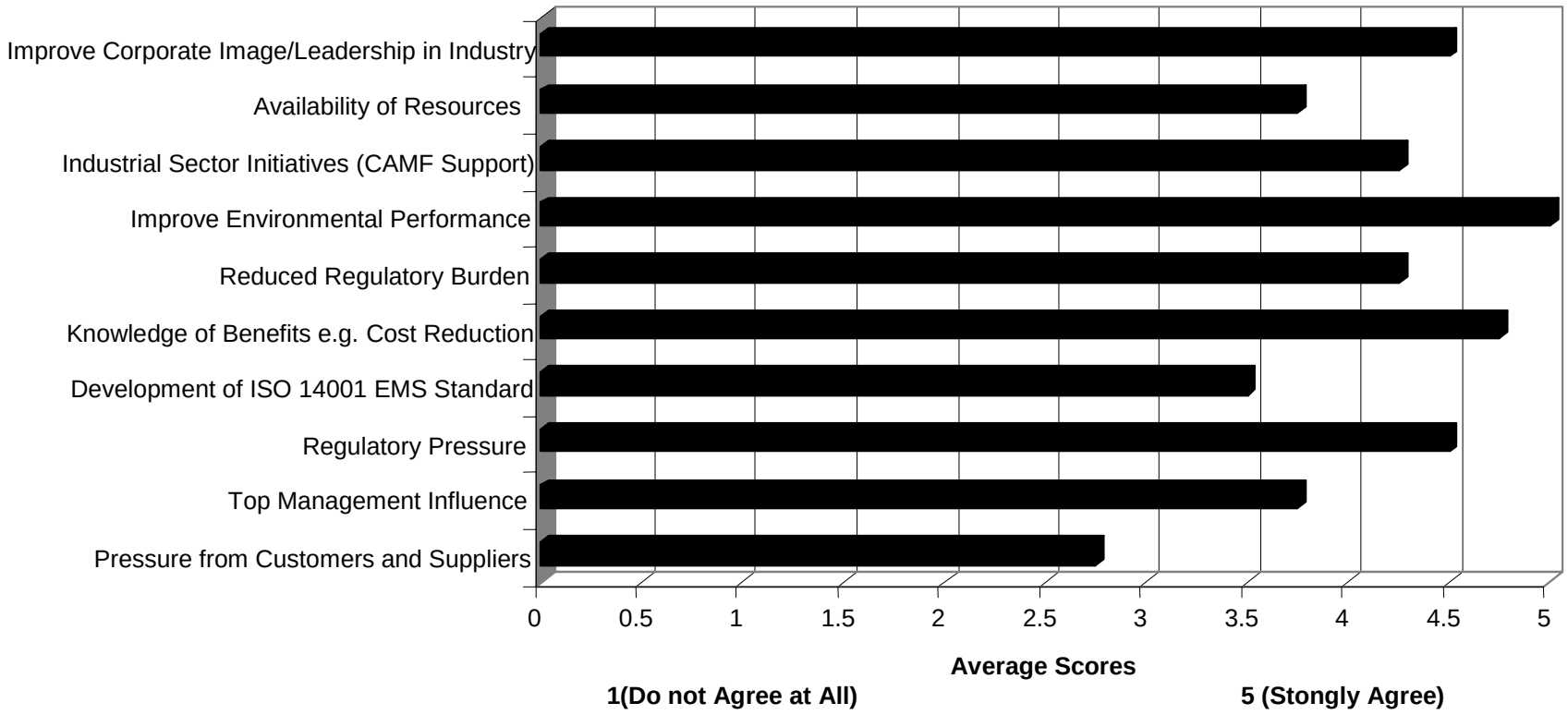
The results of their responses are tabled below (Table 4) and graphed (Figure 2) to illustrate the ranking of these factors by SMEs. A discussion section follows the graph.

Table 4: Ranking of Triggers for Implementing P2 Practices by SMEs

Triggers for P2	SME1	SME2	SME3	SME4	Average Score
Pressure from Customers and Suppliers	1	2	3	5	2.75
Top Management Influence	1	5	4	5	3.75
Regulatory Pressure	3	5	5	5	4.5
Development of ISO 14001 EMS Standard	3	1	5	5	3.5
Knowledge of Benefits e.g. Cost Reduction	4	5	5	5	4.75
Reduced Regulatory Burden	5	2	5	5	4.25
Improve Environmental Performance	5	5	5	5	5
Industrial Sector Initiatives (CAMF Support)	3	5	5	4	4.25
Availability of Resources	4	4	3	4	3.75
Improve Corporate Image/Leadership in Industry	4	5	4	5	4.5

Figure 2: Triggers for Implementing P2 Practices

(Average Score of Four SMEs)



In absolute terms, the top three stimuli or motivational factors ranked by the SMEs studied (on average) were 'Improve Environmental Performance', 'Knowledge of Benefits' (e.g. Cost Reductions), followed by 'Regulatory Pressure' and 'Improve Corporate Image/Leadership in Industry' with an even score. The goodwill of SME representatives in protecting the environment was reflected by a perfect score of 5 received for the 'Improve Environmental Performance' category. However, one may wonder if this specific stimulus had a 'window-dressing' effect – especially since none of the participants expressed genuine concern for the environment in Question 4 (open-ended question format). Nonetheless, not only did the participants recognize the benefits of pollution prevention practices to the environment, but also linked its benefits to making good business sense. Cost reduction was mentioned spontaneously as the most influential factor during interviews, as all the participants reported savings on their waste management costs. The influence of regulatory pressure also seemed to be relatively strong, but perhaps not the only reason for adopting P2 practices. Three out of four SMEs had actively participated in voluntary initiatives prior to the CEPA and City of Toronto By-law requirements. In fact, SME2 and SME3 had initiated their pollution prevention methods almost 10 – 15 years ago. However, it is fair to say that since SME1 (smallest SME) had not voluntarily implemented P2 measures previously, its main motives were initiated by the incorporation of P2 into Toronto's Sewer By-law. In addition, majority of participants seemed genuinely determined to set precedents and lead their industry with practical examples.

The general impression sensed during the interviews was that the SME representatives were rather bitter about the regulatory push towards P2, with the perception that the pollution prevention provisions, especially at the local level (e.g. Toronto's Sewer By-law limits), are more stringent than in other competing jurisdictions. Perhaps the stringent By-law limits provide little flexibility to business owners – something that they had previously enjoyed while adopting voluntary measures. Some argued that the stringent By-law limits could ultimately drive them to move their businesses out of the City of Toronto; perhaps into jurisdictions with fewer environmental restrictions.

'Industrial Sector Initiatives (CAMF)' and 'Top Management Influence' ranked fourth and fifth respectively as additional influences on their actions. All the firms' representatives expressed the positive attitudes of their corporate leaders towards the adoption of pollution prevention programs. Three out of four firms surveyed were active members of the Canadian Association of Metal Finishers (CAMF). In fact, their company representatives repeatedly addressed the integral role that CAMF played towards implementing P2 projects. For SME1, membership with the Emery Creek Environmental Association (mentioned earlier) may have been a motivator towards adapting P2 practices.

'Pressure from Customers and Suppliers' received the lowest ranking among the SMEs surveyed. The small SME representatives stated that this factor had little relevance towards their P2 effort, since they are not pressured by their clients or suppliers to incorporate P2 measures. The Technical Manager for SME2 remarked on their long standing reputation with clients and government officials, and noted their achievement award from the Ontario Ministry of the Environment's (MOE) Pollution Prevention Pledge Program (P^4) in 1994, for initiating various metal recovery methods. However, meeting customer demands and managing supply chain issues were slightly more important factors for medium-sized firm representatives than for those of small firms surveyed. For example, the Environmental Manager for SME3 explained that their actions are severely impacted by their clients from the Automotive Industry. Similarly, the Environmental Manager for SME4 agreed on being influenced by their customers. All in all, the positive corporate culture (towards P2) sensed among the participants could be a significant contributing factor to the pro-active actions adopted by the SMEs surveyed.

Question 12

An Inquiry into the management practices of the firm:

- **Who initiated the pollution prevention effort at your firm?**
- **Was top-management committed to the program?**
- **Did employees receive training?**
- **Do you have an existing Employee Recognition Program?**
- **Do you frequently communicate with your customers and suppliers? Do they play a role in the choices made by your firm to reduce or eliminate the targeted pollutant/waste stream?**

Intent of the Question

According to Greska & Ford (2000), pollution prevention projects can be driven by a variety of internal as well as external factors (discussed in Chapter 1), yet the common thread that connects each is a corporate commitment to foster the creativity, empowerment, and commitment of every employee. This question intended to examine various approaches initiated by management to enhance pollution prevention practices within their firms. As suggested by Greska & Ford (2000) and Pojasek (1999), specific areas of inquiry included: designation of program coordinator with demonstrated commitment (e.g. attending training sessions, allocation of resources, voicing opinions in meetings), employee training and involvement, and managing relations with the firm's stakeholders and their needs (employees, customers, suppliers, government officials, and local community members).

Results and Discussion

Overall, the personal views of the interviewees towards the adoption of pollution prevention measures were very positive with a sense of genuine commitment towards taking care of their firms' environmental matters. In the medium-sized SMEs surveyed, the decision to start a company wide pollution prevention program was a joint effort authorized by member(s) of the corporate leadership team, which consisted of Board of Directors, General Manager(s), and the Environmental Managers. In the case of small SMEs, it was entirely up to the Production and Technical Managers to initiate P2 efforts. However, all the participants in this survey/interview session had to some point initiated P2 programs at their respective firms while playing an active role of a P2 champion. Overall, the interviewees were satisfied with the support they received from 'their' top management and expressed no concerns regarding the allocation of resources towards P2 programs.

As discussed earlier, one medium-sized SME had developed and implemented the ISO 14001 – EMS Standard, which integrated their P2 component, while the other was in the process of developing the standard. These medium-sized enterprises had organized official training sessions for their employees on adopting new P2 methods and general housekeeping procedures, with the set up of employee recognition programs as incentives. In the case of small firms, very often the managers attended seminars or information sessions and then ended up training their employees themselves. Nonetheless, none of the SMEs received training assistance from the government.

In addition, the conversations with SME representatives during the interview sessions revealed that all the SMEs are engaging in dialogue with their stakeholders, whether they be employees, government agencies, industry associations, suppliers, customers, or local community members. However, the level of participation varied with each firm. The majority of interviewees acknowledged working closely with their suppliers to ensure the usage of environmentally safe products during the manufacturing processes. For example, from time to time, the SME Managers advise their suppliers on switching to newly marketed environmentally friendly components, in order to meet the criteria set in the new regulations (e.g. the new limits on Nonylphenols by the City of Toronto). The Environmental Manager of SME3 explained that their firm had an existing 'chemical management system' in place, which required their in-house supplier to work closely with the manufacturing team to ensure that criteria such as environmental performance, environmental impact, and waste reduction are met. The SMEs also reported on regularly communicating with their customers/clients. The Environmental Manager for SME4 noted their regular participation in customer surveys which inquire on the usage of non-toxic product ingredients.

In addition, SME2, SME3, and SME4 reported having on-going dialogues with government authorities, especially in matters or requirements pertaining to the Toronto Sewer By-law. Some of the SME representatives actively lobbied an industry's perspective during the construction of the stringent City By-law limits. These companies have also maintained a close alliance with their industry association such as CAMF, whose Chair was also one of the participants in this interview. The participants explained that their CAMF membership was an excellent opportunity for them to network with various members of the same industry, and share P2 ideas and experiences, while keeping up-to-date with the current and upcoming environmental regulations. Several Managers noted its valuable benefit of voicing their opinions – as a team, versus the government officials.

It was interesting to see personal commitment from the Production Manager of SME1, as a member of the Emery Creek Environmental Association – a local community environmental awareness group. Not

only is he proud of his company's environmental achievements, but also thinks that his firm could allocate further resources towards the betterment of our environment.

5.2.3 PART 3: Benefits and Challenges of Implementing P2 Practices

Intent of Questions 13 and 14
Having implemented various pollution prevention measures, this part of the inquiry was intended to gain insights into the benefits and challenges encountered by the participating SMEs. The questions in this part were designed in hope that these firms would share their experiences of implementing P2 measures, and express their opinions on various benefits and challenges presented to them.

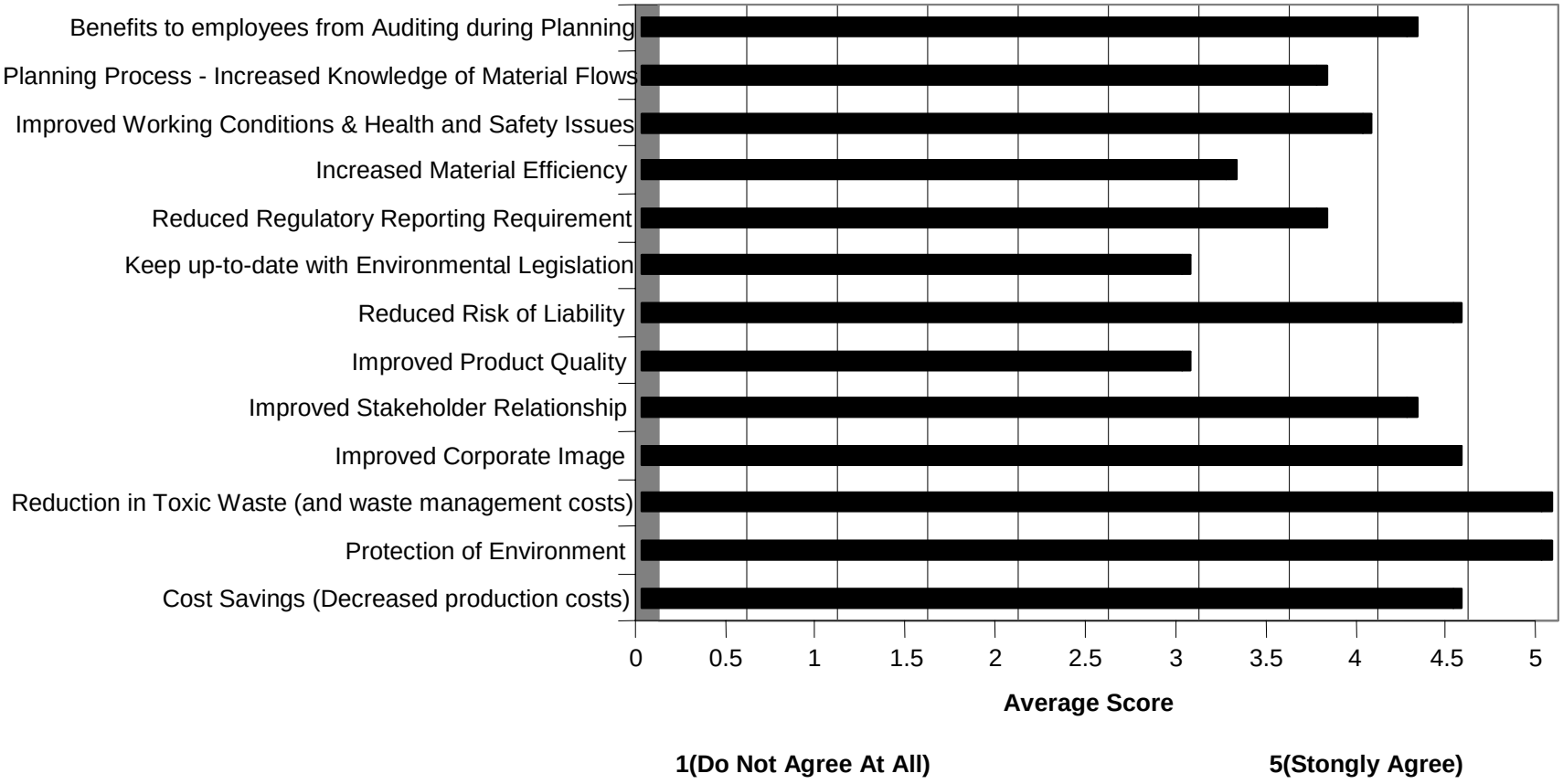
Question 13
Prior to asking this question, some of the benefits of implementing pollution prevention strategies were researched from the literature (reviewed in Chapter 2) and presented to the participants to evaluate on a scale of 1 to 5, where a score of 1 meant that they did not agree with the factor, while a score of 5 indicated their strong agreement (Please refer to Appendix C for further details on how this question was presented).

Results and Discussion
The results of their responses are tabled below (Table 5) and graphed (Figure 3) to illustrate the ranking of benefits chosen by SMEs. A discussion section follows in the end.

Table 5: Ranking of Benefits of Implementing P2 Practices by SMEs

Benefits of Implementing P2 Practices	SME1	SME2	SME3	SME4	Average Score
Cost Savings (Decreased production/operational costs)	4	5	5	4	4.5
Protection of Environment	5	5	5	5	5
Reduction in Toxic Waste (and waste management costs)	5	5	5	5	5
Improved Corporate Image	5	4	4	5	4.5
Improved Stakeholder Relationship	4	4	4	5	4.25
Improved Product Quality	4	3	3	2	3
Reduced Risk of Liability	4	4	5	5	4.5
Keep up to date with Environmental Legislation	2	3	4	3	3
Reduced Regulatory Reporting Requirement	5	2	4	4	3.75
Increased Material Efficiency	3	4	3	3	3.25
Improved Working Conditions & Health and Safety Issues	5	4	3	4	4
Planning Process – Increased Knowledge of Material Flows	2	4	4	5	3.75
Benefits to employees from Auditing during Planning	4	4	4	5	4.25

Figure 3: Benefits of Implementing P2 Practices
(Average Score of Four SMEs)



According to the SMEs studied, their top two benefits of implementing pollution prevention practices were, 'Protection of the Environment' and 'Reduction in Toxic Waste (and waste management costs)' -- both of which received a perfect score of 5 from the participating SMEs. Encouragingly, not only did the participants link pollution prevention practices to their obvious benefits to the environment, but also recognized the value-added benefits to the business bottom line. The Environmental Managers of SMEs strongly agreed that pollution prevention practices led them to reduce their toxic waste generation and cut down on their waste disposal costs.

Next, benefits 'Reduction of Production/Operational Costs', 'Improved Corporate Image', and 'Reduce Risk of Liability' all achieved equivalent scores, followed by 'Improve Stakeholder Relationships', and 'Benefit to Employees from Auditing during Planning', which ranked third in the overall ranking. In addition to achieving decreased waste management costs, the SMEs also reported on reducing their production/operational costs by implementing P2 practices. In some cases, these costs were projected with a belief that pollution prevention would lead to cost recovery over time. The SME representatives also believe that their pro-active actions enable them to maintain favorable relations with their stakeholders, i.e. government authorities and local community members, while reflecting an improved company image.

Furthermore, the SME representatives also admitted to benefiting from the planning process during the development of their P2 Plans. For example, the auditing during planning created awareness among their employees about various manufacturing processes and the associated pollution/waste sources, and enabled significant opportunities for employees to engage in pollution prevention activities – thus improving employee morale.

The remaining benefits suggested did not receive much support among the SMEs researched. For example, SME participants were hesitant to believe that their firms would face 'Reduced Regulatory Reporting Requirements' by incorporating P2 practices. According to them, they would still have to comply with the already set regulatory requirements. In addition, the Environmental Managers of SMEs were not convinced that P2 practices would lead their firms to keep up-to-date with environmental legislation, or increase material efficiency. The benefit 'Improved Product Quality' received the lowest overall ranking -- perhaps due to the fact that the majority of their source reduction methods incorporated were indeed process changes, rather than product changes. Hence, it is assumed that the SMEs did not perceive P2 as an opportunity for product improvement.

Question 14

Prior to asking this question, some of the factors that challenge or in some cases prevent firms from implementing pollution prevention methods were researched from the literature (reviewed in Chapter 2) and presented to the participants to evaluate on a scale of 1 to 5, where a score of 1 meant that they do not agree with the factor, while a score of 5 indicates their strong agreement.

Results and Discussion

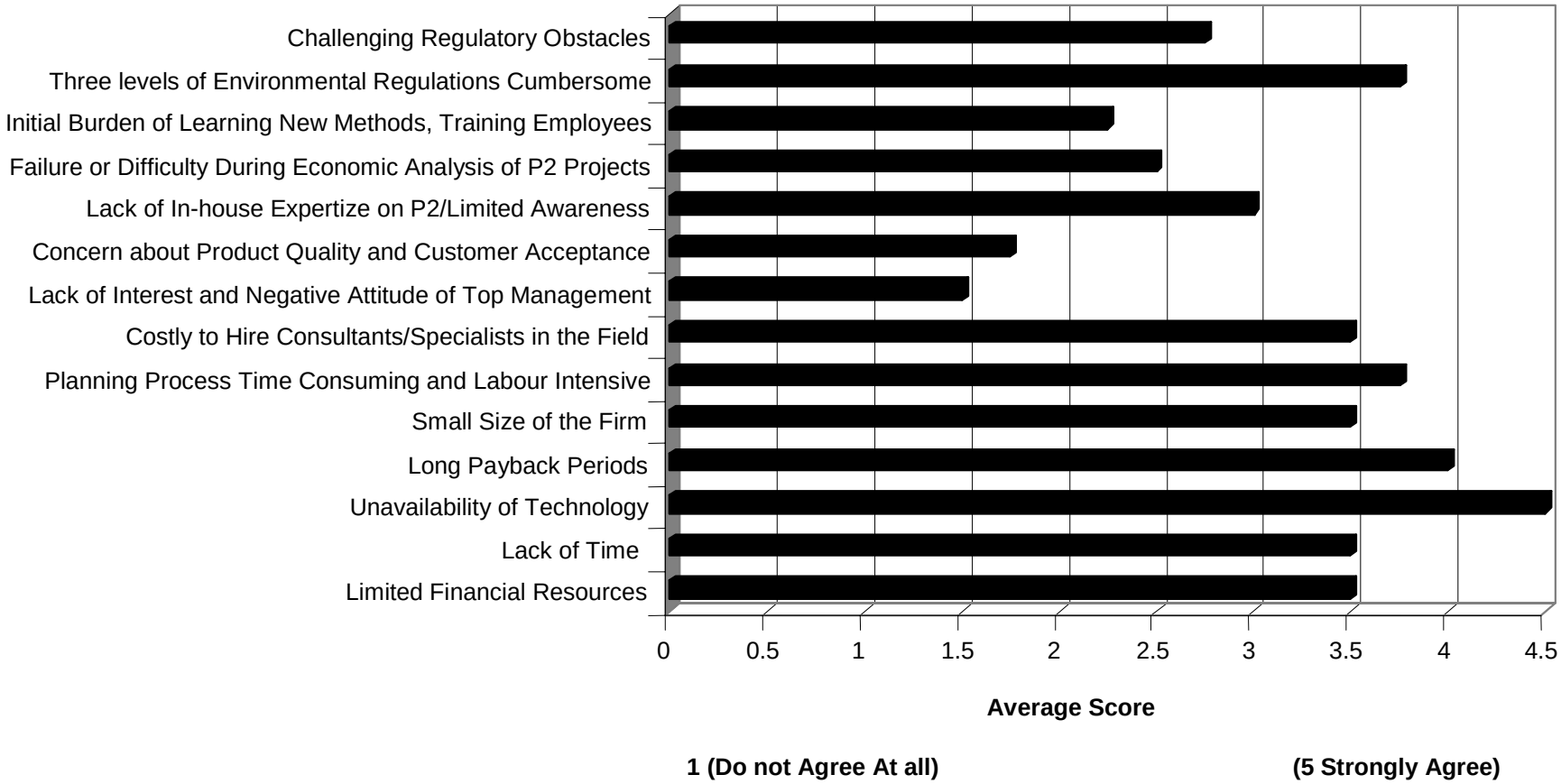
The results of their responses are tabled below (Table 6) and graphed (Figure 4) to illustrate the ranking of challenges chosen by SMEs. A discussion section follows in the end.

Table 6: Ranking of Challenges of Implementing P2 Practices by SMEs

Challenges of Implementing P2 Practices	SME1	SME2	SME3	SME4	Average Score
Limited Financial Resources	4	2	4	4	3.5
Lack of Time	3	3	4	4	3.5
Unavailability of Technology	4	5	5	4	4.5
Long Payback Periods	3	4	5	4	4
Small Size of the Firm	5	2	3	4	3.5
Planning Process Time Consuming and Labor Intensive	5	2	3	5	3.75
Costly to Hire Consultants/Specialists in the Field	1	5	3	5	3.5
Lack of Interest and Negative Attitude of Top Management	2	1	2	1	1.5
Concern about Product Quality and Customer Acceptance	3	1	2	1	1.75
Lack of In-house Expertise on P2/Limited Awareness	3	2	5	2	3
Failure or Difficulty During Economic Analysis of P2 Projects	2	2	4	2	2.5
Initial Burden of Learning New Methods, Training Employees	2	2	3	2	2.25
Three levels of Environmental Regulations Cumbersome	4	4	4	3	3.75
Challenging Regulatory Obstacles	3	2	3	3	2.75

Figure 4: Challenges of Implementing P2 Practices

(Average Score of the four SMEs)



By far, the greatest challenge of implementing P2 practices reported by the SMEs studied was the 'Unavailability of Technology'. Having recognized the importance of technological changes to their overall pollution prevention strategy, the SME representatives discussed the absence of readily available technologies for their current manufacturing processes. Many blamed it on the smaller size of their business sector. The Technical Manager for SME2 noted, "…there is very little dedicated effort in trying to come up with best technology for a small sector like Metal Finishing." Similarly, the Production Manager of SME1 thinks that larger firms have greater technological choices to prevent pollution, mainly due to their large-scale production activities which cater to larger markets. According to him, it would not be worthwhile to invest in technologies designed for large-scale production, not only due to smaller volumes they deal with, but also longer payback periods. A similar response was obtained from the Environmental Manager for SME3, who remarked on having accomplished most of their do-able P2 goals and now only awaiting advancements in technology to take them to the next level.

'Longer Payback Periods' ranked second in the overall ranking. This could be explained by the short-term focus of most SMEs, which hinders the adoption of more sophisticated, intensive capital requiring P2 methods, thereby dismissing the notion of P2 leading to financial recovery over time (Epstein & Roy, 2000; Bianchi & Noci, 1998).

Next, 'Three Levels of Environmental Regulations Cumbersome' and 'Planning Process Time Consuming and Labor Intensive' were third in the overall ranking. The conversations with the SME representatives revealed that the environmental regulations from three different levels of government were rather confusing and challenging to satisfy, with a fair bit of overlap among the three. It is generally hoped that one central body will take care of environmental issues, especially pertaining to pollution prevention in different media (air, water, and land/soil). While the SME participants generally agreed on benefiting from the P2 Planning Process, their experiences suggest that the process is time-consuming and highly labor intensive, posing a significant burden of hiring costly consulting services.

Interestingly, 'Lack of Financial Resources', 'Small Size of the Firm', 'Lack of Time', and 'Costly to Hire Consultants', were evidently not the major challenges for the SMEs studied, and ranked fourth overall. It was generally sensed that most SME participants were satisfied with the capability of their firms to implement P2 methods. None of the SME representatives stressed the unavailability of resources to implement P2 options during the interviews conducted. In fact, many thought that the size of their firm and its resources (financial) were not major obstacles towards their implementation of preventive measures. Nonetheless, many individuals agreed on having very little discretionary time to devote towards P2 issues, especially the planning process, which caused them to seek third-party assistance, i.e. consulting services. The Manager for SME1 explained that he attended most of the informational seminars on P2 and then ended up training his employees himself. However, all the participants agreed that it was costly to hire consultants/specialists in the field. For SME1, partial costs of hiring a Consultant were subsidized by OCETA. Overall, it seems that the above four challenges are present to some extent among the SMEs studied; however, these factors may not necessarily be more apparent than the ones already mentioned.

According to the SMEs studied, 'Lack of in-house Expertise' was not a significant obstacle towards the implementation of pollution prevention practices. This is hardly surprising since three out of four participating SME had received a great deal of support from their hired consultants. Since SME2 did not hire any consultants, much of their assistance was achieved from networking with government authorities and the industry association, CAMF. However, one may argue that hiring consultants or specialists in the field may actually stem from SME managers having little (if any) time, resources (human), or knowledge to deal with environmental issues in the first place (Gombault & Versteege, 1999)

Among the less agreed upon challenges ranked by the SMEs studied were 'Concern about Product Quality and Customer Acceptance' and 'Lack of Interest/Negative Attitude of Top Management'. As mentioned earlier, the SME representatives were well satisfied with the support and resources they received from their respective leadership/top management. Since the majority of the options implemented by the SMEs did not involve product changes, there seemed to be less concerns about the quality of the final product or its interferences with customer choices.

Clearly, a major challenge revealed by SMEs during the interview sessions, but not presented to them during the ranking of this study, is the differences in the interpretation of pollution prevention. Many participants argued that the use of the classical definition of P2 in legislation was one of their main challenges, ultimately requiring them to find substitutes for metals and become “metal free”.

6.0 Conclusions and Recommendations

This study was limited by a small sample size of four small and medium-sized metal finishers. Nonetheless, it provided some insights into how the concept of pollution prevention is embraced by SMEs in the same industry, while reflecting their experiences, motives, benefits and challenges. The remaining sections of this final chapter will summarize major findings and conclusions of this study, and suggest recommendations for the participating SMEs and governments involved.

6.1 Summary of Research Findings and Concluding Discussion

The research study discovered that:

- Overall, a positive business culture towards P2 was sensed among the SME representatives, with signs of genuine commitment towards taking care of their firm's environmental matters.
- The top three incentives that prompted the SMEs to implement P2 practices were: 'Improve Environmental Performance', 'Knowledge of Benefits' (e.g. cost reductions) and 'Regulatory Pressure'. However, it seems that the influence of regulatory pressure on the implementation of P2 practices is relatively stronger than admitted by the SMEs. As suggested by the BC Pollution Prevention for Small Business Group (2000), without it small SMEs would likely not engage in pollution prevention activities to the extent they have.
- Collectively, the participating SMEs believe that not only does P2 improve their environmental performance, but it also makes good business sense. In particular, the participants strongly agreed that pollution prevention practices led them to reduce their toxic waste generation and cut down on their waste disposal costs.
- The experiences of the four SMEs suggest that their greatest challenges for implementing P2 practices were the 'Unavailability of Technology', followed by 'Longer Payback Periods', 'Three Levels of Environmental Regulations Cumbersome', and 'Planning Process Time Consuming and Labor Intensive'. A general impression sensed during the interviews was that a one window regulation is desired among SMEs who find three levels of environmental regulations rather cumbersome and difficult to keep up with.

While the above observations give insights into motives, benefits, and challenges of implementing P2 practices, one may argue that these might only be stated behaviors, which may differ from the demonstrated actions of SMEs. From the overall analysis of the information gathered from the Questionnaire and the interview sessions, it is apparent that the SMEs studied had implemented pollution prevention measures to some extent. However, their methods and approaches varied due to the differences in company size, their management practices, unique culture and behavior, availability of knowledge, and financial capabilities of each SME Metal Finisher. The SMEs within the metal finishing sector had independent interests and thus handled their pollution prevention practices differently. As recommended by the BC Pollution Prevention for Small Business Working Group (2000), a significant difference was noted between the ability of small and medium-sized firms to deal with environmental issues. Also noted was variability in how the pollution prevention practices were adopted by two small-sized SMEs. Thus, as argued by Orchard (2002) and Granek (2002), SMEs within a sector are indeed diverse, and cannot be treated as a homogeneous group.

In particular, the smallest SME in this study (SME1) did not tackle the pollution prevention issue at the same scale as firms relatively larger in size (i.e. > 15 employees). SMEs having more than 15 employees (i.e. SME2, SME3, and SME4) had more experience and technical expertise in the field of pollution prevention. Although each SME exploited several source reduction techniques to target different pollutants/waste streams, the majority of the sophisticated technological changes were implemented by firms having more than 15 employees. Only one medium-sized firm reported product changes.

The medium-sized SMEs had sufficient financial resources to hire consultants to help them with the construction of their P2 plans and develop (or be in the process of developing) an ISO 14001 EMS Standard with an integrated P2 component. The small business managers solely held responsibility for coordinating their firm's environmental issues and remained with very little discretionary time to focus on

P2 issues. The constraints of the planning process were especially realized by the managers of these small firms. Yet, not all the small firms were able to reach out to their industrial sector.

All in all, one may argue that the medium-sized firms utilized greater resources towards implementation of P2 methods. However, as argued by BC Pollution Prevention for Small Business Working Group (2001), pollution prevention is not necessarily less valuable in small business than in large enterprise. After all, deep pockets may not be necessary for incorporating simple preventive measures such as better housekeeping/operating practices. Furthermore, opportunities to adopt P2 in small businesses may be uniquely rewarding; after all change in small organizations is easier and more immediate than in large organizations.

In practice, although all four SMEs were successful in developing their P2 Plans (and getting them approved by regulatory officials), not all the options identified during the planning phase were implemented -- since implementation is not mandatory. Often, options with shorter payback periods and low initial costs are chosen first. Further research is recommended to examine a variety of approaches that could be jointly adopted by government and industry (i.e. co-operative balanced effort) to drive the P2 planning process towards implementation.

6.2 Recommendations

Based on the overall analysis, the following recommendations are proposed for the participating SMEs and governments involved. However, these recommendations may also be applied to SMEs in general (i.e. in other business sectors).

Recommendations For SMEs

1. If possible, the representatives of SMEs (especially SME1 & SME2) should organize educational workshops and training sessions for their employees regarding new possibilities to prevent pollution. Such activities can help to involve all employees and gear towards a positive P2 culture in the firm. However, it is realized that organizing training sessions in small firms is difficult. In such cases, the managers should provide funding for employees to participate in P2 training through centralized organizations, e.g. fora organized by the Canadian Centre for Pollution Prevention (C2P2).
2. As recommended by Cramer & Reijenga (1999), all SMEs, especially small firms, should devote attention to developing networks with similar firms in their sector. Such networking efforts can spread the expertise from larger to smaller companies and also lighten the burden placed on individual managers for managing information related to their firm's environmental matters. The large or medium-sized organizations belonging to one sector can also encourage smaller ones by example, providing informal advice and reflections on P2 experiences.
3. SMEs should especially reach out to their respective industry associations (sectors) to take advantage of their initiatives and knowledge capacities. This may particularly be the case for SME1 that can benefit from many of the programs initiated by the Canadian Association of Metal Finishers. Building a network of this sort may generate "momentum" for pollution prevention in small organizations.
4. As stated by Robert Pojasek (2003), "P2 involves a lot more than just having an expert walk around your facility and come up with the right answers." While assistance from consultants is generally supported, it is highly recommended that all SMEs maintain a system to find and solve their own pollution problems. In the long run, building expertise in one's own organization can help to maintain a sustainable P2 program.
5. All SMEs should be able to take advantage of initiatives, knowledge and capacities of other partners or third parties, for instance non-governmental organizations, e.g. OCETA, consultancy agencies, universities and research institutes. These organizations can encourage SMEs to implement P2 projects by keeping pollution prevention on their agendas (Bruijn & Hofman, 2000). Such efforts may also help to link the technological gaps that the participating SMEs are currently facing.
6. The Managers of SMEs should ensure continuous involvement of all employees in P2 Programs. Communicating reduction targets and progress to all levels of employees can be an important motivating factor for employees. It is also important to educate them on the important role that they play in achieving reduction targets. Generation of practical examples and illustration of what has to be

achieved (by keeping monthly or weekly inventory boards of how much pollutants/waste they have reduced or eliminated) can be a motivating factor to achieve set targets.
7. As Bruijn & Hofman (2000) suggest, a full transformation towards pollution prevention will require companies to make product changes as well – which are clearly lacking in the methods adopted by participating SMEs. The SMEs may need to aim at far-reaching changes and not just short-term process changes in order to develop sustainable production systems.
8. SMEs involved may also want to take advantage of programs initiated by regulators themselves, who can be great resources for providing information required to comply with the regulations. SME2 is a great example to follow, as its manager/owner received the majority of his assistance in constructing P2 plans from government officials at the federal and local level.

Recommendations for all levels of Governments

1. It is imperative for all levels of government to collaborate on the issue of pollution prevention. The government as a whole can look into developing a team that can generally take care of all legislative requirements pertaining to pollution prevention. As recommended by the BC Pollution Prevention for Small Business Working Group (2001), P2 should be considered as one tool to be incorporated into federal, provincial and local waste management frameworks for all industries/enterprises.
2. As recommended by Andreea Dulipovici (2001), all levels of government should view SMEs as entities with different environmental behaviors. As seen in this study, all SMEs may not necessarily have the time or environmental expertise to develop and implement P2 plans. Therefore, regulatory authorities should become more sensitive to specific barriers that SMEs face and offer practical solutions designed to fit SMEs' needs, e.g. local government can make recommendations specifically for P2 Planning in SMEs.
3. Where informational gaps exist, governments should provide accessible guidance regarding legislation and regulations impacting SMEs.
4. Conduct pollution prevention training activities and outreach programs to facilitate the diffusion of pollution prevention concepts among SMEs. On-going sector by sector training programs, especially at the local level, can aid SMEs to prepare pollution prevention plans and find workable cost-effective pollution prevention strategies to implement. A centralized public-sector institutional partner can assist in delivering the training program.
5. Provide financial incentives for P2 options mentioned in P2 plans in return for a commitment towards implementation. For example, subsidies or tax breaks on P2 investments (innovative technologies) identified in their P2 Plans (Pollution Prevention Planning Implementation Advisory Committee, 2001).
6. At local level, the government can annually publish a high-profile recognition list of companies and communities involved in P2 planning as environmental leaders.
7. Governments can form partnerships with third party delivery agents (e.g. non-profit organizations) to provide technical assistance with financial incentives, e.g. offer subsidies or cost sharing for carrying out P2 assessments at small and medium facilities. Most SMEs welcome centralized information or programs housed in non-profit organizations as opposed to government agencies, as such programs secure client confidentiality.
8. Governments can explore avenues to align their compliance and enforcement programs with pollution prevention efforts. Such coordinated efforts can initially focus on pilot projects with industry sectors where P2 planning can be implemented as a compliance (or compliance plus) option to address environmental issues beyond those covered by regulation. For example, standard permits or compliance documentation can be changed to address P2 where possible, or where P2 is promoted through compliance inspectors who refer regulated entities to professional technical assistance providers (locally), or in some cases the inspectors themselves can recommend P2 options after conducting audits (Helms & Bickel, 2001). Programs such as these can be integrated by provincial and local governments. Experience in the U.S. has shown that coordinating P2 assistance with compliance efforts can result in increased awareness of environmental responsibilities within the regulated community, with greater willingness to improve and broaden interest in P2 strategies.

6.3 Concluding Statement

It is obvious that pollution prevention practices are underway in businesses. However, to what extent is the concept of P2 embedded within organizations – in the long term – is an interesting question. Perhaps a major drawback of practicing P2, witnessed among the SMEs studied, is that they are focusing on P2 with messages such as “adopt P2 methods” or “prepare P2 Plan” rather than as the start of an on-going process requiring continuous improvement. According to Phipps (1995), P2 is not merely a set of actions or programs – but it is a way of thinking and an approach to problem solving. It is an attitude – which applies to all things, at all times (CIELAP, 1999). As such it requires a change in attitude, involvement, and actions from all stakeholders in society.

In the years to come, what will be important is to educate society at large on its role in incorporating pollution prevention into daily activities, processes, and products through informed design and decision-making process (Phipps, 1995). Organizations need to adopt pollution prevention as an attitude and not a point solution, as they incorporate environment into their decision-making processes. After all, sustainable results demand an on-going commitment and continuous process of improvement. In the end, it is the combined effort of corporations, government bodies, non-government organizations, and fellow citizens that will lead to the development of a holistic, preventive approach to managing our environment for a sustainable, healthy future.

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Canadian Centre for Pollution Prevention – Canada's Foremost Pollution Prevention Resource: http://www.c2p2online.com

Canadian Council of Ministers of the Environment (CCME): http://www.ccme.ca/initiatives/pollution.html

Canadian Pollution Prevention Information Clearinghouse: www.ec.gc.ca.cppic

Emery Creek Environmental Association Home Page: http://home.interlog.com/~emery/

Environment Canada:
- The Canadian Environmental Protection Act (CEPA) Environmental Registry: http://www.ec.gc.ca/CEPARegistry/plans/P2/
- The National Office of Pollution Prevention (NOPP): http://www.ec.gc.ca/NOPP/

Ontario Centre for Environmental Technology Advancement (OCETA) Home Page: http://www.oceta.on.ca

Ontario Ministry of the Environment's Website: http://www.ene.gov.on.ca/envision/coopagreements/launch.htm

Appendices

APPENDIX A – A Generic Questionnaire for SMEs

Name of the Organization:
Address:
Contact Name: **Title:** **Phone number and Email:**
Size of the Company (in terms of # of employees): **Total facilities owned by the Company:** **If many facilities, give the # of employees at your facility:**
Is your Organization an existing Member of the Metal Finishing Industry Pollution Prevention Project? **❑ YES ❑ NO ❑ PAST MEMBER in the YEAR** _____

PART 1: ENVIRONMENTAL ACTIVITIES AND COMMITMENT WITHIN AN ORGANIZATION

1. Please describe who takes care of the environmental matters at your facility i.e. Environmental Managers, Coordinators, Health and Safety Managers, Production Manager etc. If you have an existing environmental department or Green Team at your firm, please describe its structure.

2. Does the company have an environmental policy, which includes commitment for pollution prevention (P2)? If yes, is it possible to get a copy of this policy?

3. Does your firm have an Environmental Management System (EMS) such as the ISO 14001 Standard, in place? If yes, is P2 incorporated into the EMS or did you construct your P2 plan within an existing EMS? If no, did you start your P2 plan from scratch? (Please record other guidance documents/resources you utilized while constructing your P2 plans).

4. What is the organization's main motive/trigger to improve its environmental performance?

PART 2: POLLUTION PREVENTION PRACTICES IN SMEs

5. Did you utilize the P2 planning process as a main method used to promote P2 within your organization, and develop a P2 Plan? If yes, please answer the questions below:
    a. Did you hire any professional consultants to help you with the planning process? If not, did the company employees seek assistance elsewhere?
    b. How long did the planning process take?
    c. How many options were implemented (or which options were implemented from the total options generated during the planning stage).

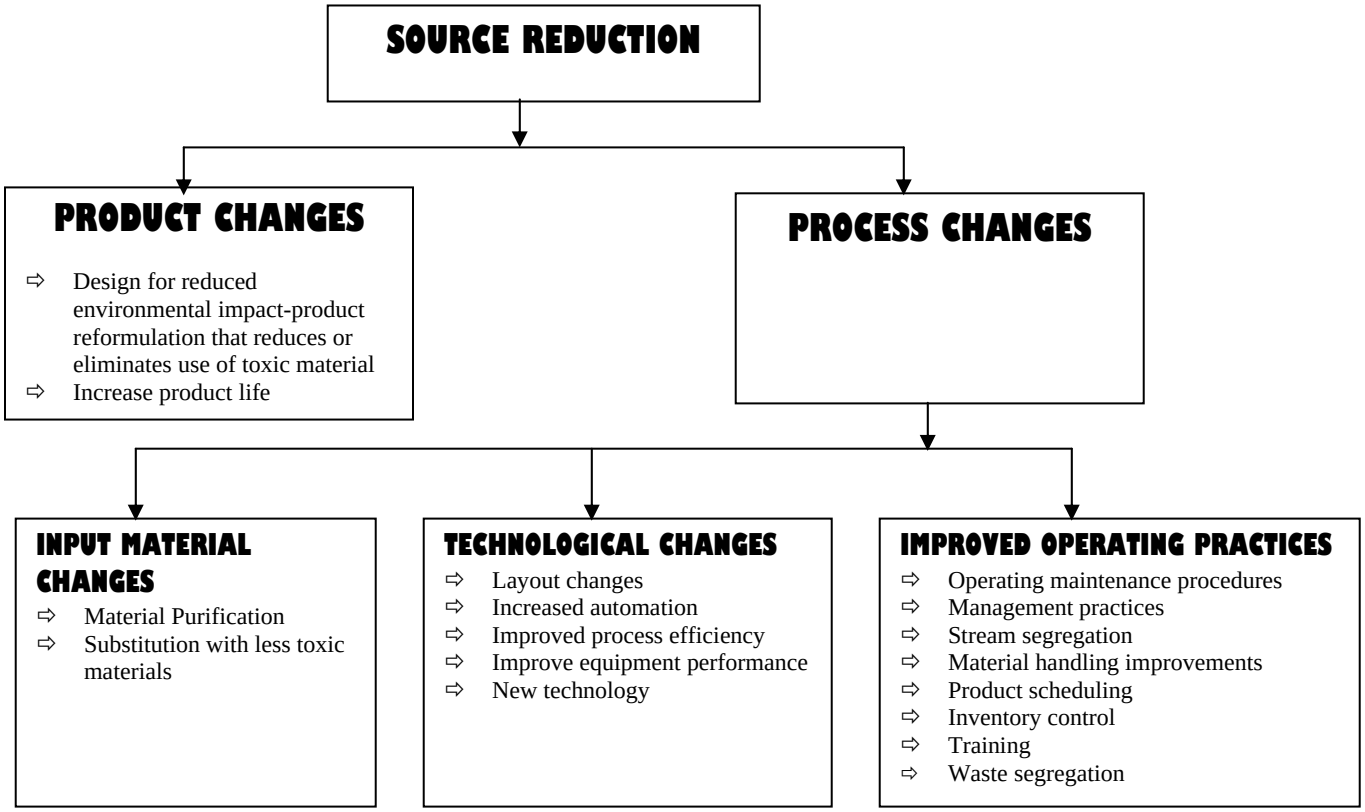
6. Please outline the main processes conducted at your metal finishing facility. e.g. metal cutting, cleaning/de-greasing, plating, painting etc.

Pollution Prevention Methods

7. From the processes listed above, please choose one process (e.g. plating or de-greasing) and identify the main pollutants/waste stream generated from this process (e.g. plating or cleaning solution). For the purposes of this survey, you are kindly asked to provide information on pollution prevention initiatives on this particular substance. Hence, it is suggested that you choose the one on which significant pollution prevention efforts have been achieved.

8. What specific P2 methods (i.e. source reduction methods outlined below) did you use to reduce/eliminate the pollutant/waste stream identified above?

    Note: Pollution prevention methods imply to the standard source reduction methods illustrated below, including in-process recycling of valuable resources on-site, and energy conservation.



Source Reduction Methods

For the purposes of this survey, please provide a description of the process chosen (Q.6) before the P2 initiatives, along with the changes to this process after the implementation of the product/process changes. You can provide copies of any previous write-ups etc.

9. Did this pollution prevention method, in your opinion achieve the reductions expected? If there was a decrease in the use or generation of this pollutant/waste stream after implementing P2 strategy/or after modification, please quantify the results.

10. Did you save money, and decrease production costs and waste management costs for implementing this method(s)? Please quantify the amount.

11. For each of the following statements listed below, please indicate how strongly you agree that these factors, or motives, led your firm to implement the P2 methods described in your questionnaire and interview session. A scale of 1 to 5 has been used where a score of **1 means you do not agree** at all and a score of **5 means that you strongly agree** to these factors/motives that have been identified below.

Pressure from the Stakeholders: influence from our suppliers and customers

1 2 3 4 5
Do not agree at all *Strongly agree*

Pressure from the Stakeholders: Influence from our top management

1 2 3 4 5
Do not agree at all *Strongly agree*

Regulatory pressure in the form of Laws and Regulations (e.g. Toronto's Sewer By-law)

1 2 3 4 5
Do not agree at all *Strongly agree*

Implementation of the ISO 14001 Environmental Management System (EMS) Standard (and thus an Environmental Policy that commits our firm to reduce our environmental impacts and adapt P2 measures)

1 2 3 4 5
Do not agree at all *Strongly agree*

Knowing that our firm would benefit from implementing P2 methods e.g. cost savings

1 2 3 4 5
Do not agree at all *Strongly agree*

Knowing that these measures may possibly lead to reduced regulatory burden (e.g. reduced reporting due to decrease in hazardous waste)

1 2 3 4 5
Do not agree at all *Strongly agree*

A belief that the measures implemented would lead to improved environmental performance

1 2 3 4 5

Do not agree at all *Strongly agree*

Due to strong guidance, support, and influence from the Industry Association (e.g. CAMF)

1 2 3 4 5
Do not agree at all *Strongly agree*

Availability of resources to implement proactive measures

1 2 3 4 5
Do not agree at all *Strongly agree*

Improve Corporate Image/ Leadership in the Industry

1 2 3 4 5
Do not agree at all *Strongly agree*

Note: Please add other points not mentioned above, but relevant to your firm.

12. MANAGEMENT PRACTICES OF THE FIRM

a. Who initiated the pollution prevention effort at your firm?

b. Was top-management committed to the program?

c. Did employees receive training?

d. Do you have an existing Employee Recognition Program?

e. Do you frequently communicate with your customers and suppliers? Do they play a role in the choices made by your firm to reduce or eliminate the targeted pollutant or waste stream?

BENEFITS AND CHALLENGES OF IMPLEMENTING POLLUTION PREVENTION MEASURES

13. For each of the statements listed below, please indicate how strongly you agree that these are the P2 benefits enjoyed by your firm while implementing the P2 strategies outlined in your questionnaire and

interview sessions). Again a scale of 1 to 5 has been used, where a score of 1 means you do not agree at all and a score of 5 means you strongly agree.

Cost savings – The P2 options led us to decreased production or operational costs (or a belief that the measures will lead us to cost recovery over time)

1 2 3 4 5
Do not agree at all *Strongly agree*

Protection of the environment

1 2 3 4 5
Do not agree at all *Strongly agree*

Reduction in hazardous/toxic waste -- decreased waste management costs

1 2 3 4 5
Do not agree at all *Strongly agree*

Improved corporate image

1 2 3 4 5
Do not agree at all *Strongly agree*

Improved stakeholder relationship (e.g. improved accountability with suppliers, customers and government officials)

1 2 3 4 5
Do not agree at all *Strongly agree*

Improved product quality

1 2 3 4 5
Do not agree at all *Strongly agree*

Reduced risk of liability

1 2 3 4 5
Do not agree at all *Strongly agree*

We were able to keep up-to date on environmental legislation

1 2 3 4 5
Do not agree at all *Strongly agree*

Reduced regulatory reporting requirement (due to reduced load on waste treatment system – thus easier to stay in compliance)

1 2 3 4 5
Do not agree at all *Strongly agree*

Increased material efficiency

1 2 3 4 5
Do not agree at all *Strongly agree*

Improved working conditions and reduced health and safety risks for workers

1 2 3 4 5
Do not agree at all *Strongly agree*

The P2 planning process increased our knowledge of material flows within the company processes, resulting in a structural approach to eliminate or reduce environmental impacts e.g. generation of waste.

1 2 3 4 5
Do not agree at all *Strongly agree*

The audit process during planning gave our employees an opportunity to participate and become aware of our production processes in detail, as well as improve employee morale

1 2 3 4 5
Do not agree at all *Strongly agree*

Please feel free to add other benefits which are not mentioned above but enjoyed by your firm.

14. For each of the following statements, please indicate how strongly you agree that they **challenged or in some cases prevented your firm** from implementing pollution prevention strategies/methods described in the questionnaire and interview session. Again, a scale of 1 to 5 has been used where a score of 1 means you do not agree at all and a score of 5 means you strongly agree. **Note:** keep in mind that you are indicating challenges/obstacles specific to your organization while implementing P2 strategies.

Unavailability of capital due to limited financial resources

1 2 3 4 5
Do not agree at all *Strongly agree*

Lack of time to look into other P2 options

1 2 3 4 5
Do not agree at all *Strongly agree*

Unavailability of the technology -- technological gaps

1 2 3 4 5
Do not agree at all *Strongly agree*

Longer payback periods – high initial operational costs with cost recovery over time

1 2 3 4 5
Do not agree at all *Strongly agree*

Small or medium size of our firm prohibited us from implementing sophisticated P2 options

1 2 3 4 5
Do not agree at all *Strongly agree*

The planning process was very time consuming and highly labor intensive (in some cases requiring us to hire costly third-party assistance i.e. hire external consultants)

1 2 3 4 5
Do not agree at all *Strongly agree*

It was costly for us to hire consultants to complete the P2 planning work

1 2 3 4 5 N/A
Do not agree at all *Strongly agree*

A lack of interest and negative attitude of top management

1 2 3 4 5
Do not agree at all *Strongly agree*

A concern about a change in our product quality, or customer acceptance of the product

1 2 3 4 5
Do not agree at all *Strongly agree*

Lack of in-house expertise on pollution prevention or limited awareness of P2 options that could be generated within the firm

(For example, you did not have ready access to a central source of information on pollution prevention techniques).

1 2 3 4 5
Do not agree at all *Strongly agree*

Failure or difficulty in including the hidden costs of environmental solutions during economic analysis of P2 Projects

1 2 3 4 5
Do not agree at all *Strongly agree*

Implementing new P2 options led to an initial burden of learning new concepts and methods, as well as training our employees

1 2 3 4 5
Do not agree at all *Strongly agree*

Satisfying environmental regulations from three different levels of government was too cumbersome

1 2 3 4 5
Do not agree at all *Strongly agree*

Regulatory Obstacles – Regulations were a barrier to implementing some P2 options. ***For example, changing to another feed material required us to change our existing Certificates of Approval or maybe most of the regulations still focus on the end-of-pipe measures***

1 2 3 4 5
Do not agree at all *Strongly agree*

Please feel free to add other challenges/obstacles faced by your firm, but not mentioned above.