

March 12, 1997

# **Pollution Prevention Assistance in the Automotive Supply Chain**

## **A Study of Northeast Ohio**

by

Susan Helper, Ph.D

Center for Regional Economic Issues

Case Western Reserve University

with

Michael Allen, Ph.D.

Patricia Clifford

William D. Henderson

David Hochfelder

Helen Rozwadowski, Ph.D

*A report submitted to CAMP, Inc.*

*Manufacturing Environmental Management Services*

*March 1997*

Thanks to Gus Eskamani, Michael S. Fogarty, Christine Williams, and Amy B. Whitehead for their helpful comments, and to Gjalte de Jong, Elliot Bendoly, and Dilek Karaomerlioglu for expert computer assistance.



## EXECUTIVE SUMMARY

The automotive industry remains a major employer in Northeast Ohio, although industry employment fell 25% between 1975 and 1993. The rate of loss has slowed in the last decade, but the region has not recaptured the share of US auto industry jobs that it enjoyed 20 years ago. The auto industry includes not only automotive assembly, but also metal stamping, heat treating, injection molding, and many other processes.

The goal of this study is to assess the viability of the automotive supply chain in Northeast Ohio, and to improve the supply chain's performance by recommending ways that the generation of waste could be prevented. In this study, we use the term 'waste' to describe all types of resource use which do not add value to a product. We divide waste into two categories: 'pollution', which refers to unwanted substances emitted into the environment, and 'unnecessary production effort', which leads directly to wasted human exertion and indirectly to additional pollution. This definition allows us to look at both the environmental and the competitive sustainability of the industry in this area, and to examine whether there are tradeoffs between them.

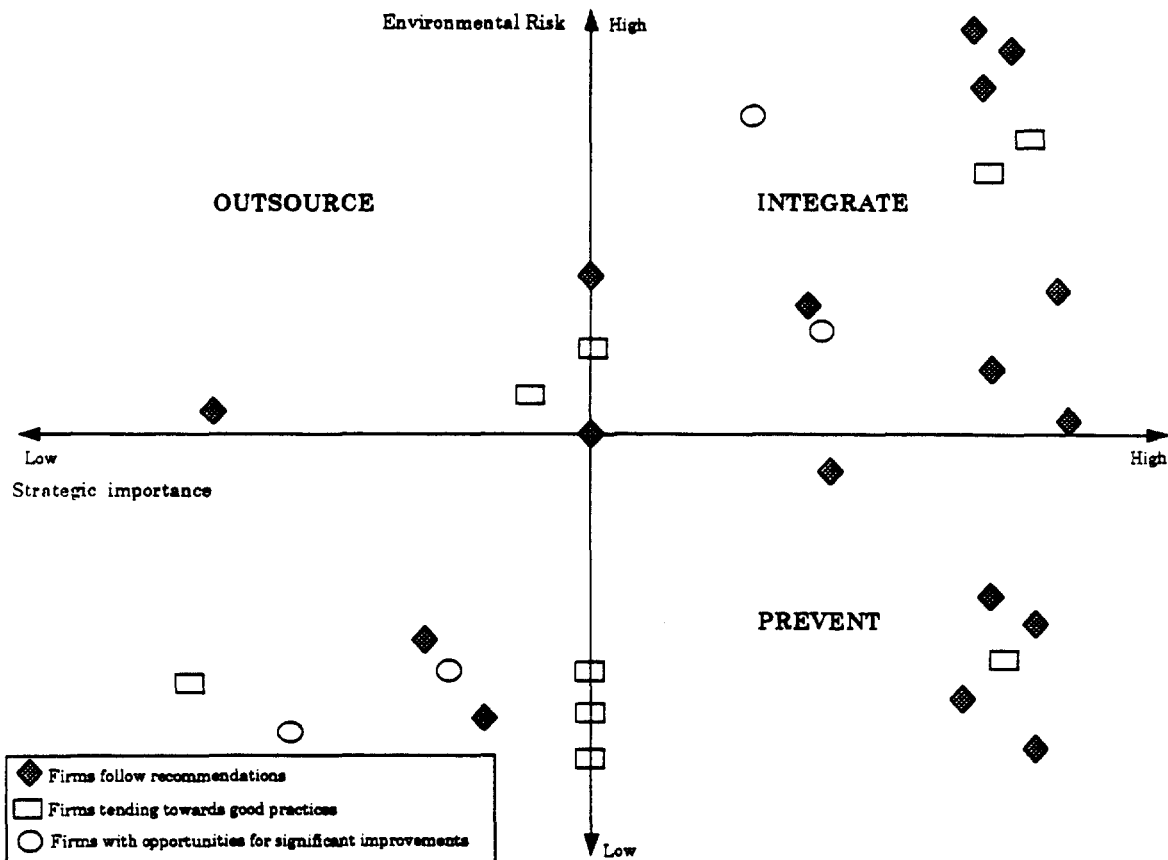
The study is based on two sources of data. The principal source is a series of 30 interviews of Northeast Ohio automotive suppliers carried out by the authors in summer 1996. Because of the high response rate to our request for interviews, we believe this sample, though small, is representative of the population of Northeast Ohio automotive suppliers. The plants visited ranged in size from several thousand employees to a few dozen, and represented not only first-tier suppliers (those who supply directly to automakers), but also second, third, and fourth tier. The second source of data was a postal survey carried out in the United States and Canada in 1993 by one of the authors (Helper). These data allow us to compare the performance of Northeast Ohio plants with those of competitors nationwide.

The study looks first at pollution-control techniques employed at area firms. The firms we interviewed generated a variety of types of wastes; the most common were scrap metal, oils, and coolants. Firms dealt with these wastes by a variety of methods, which we categorized as pollution prevention, recycling/re-use, and end-of-pipe treatment. We encountered examples of pollution prevention in about one-quarter of our sample. These examples were evenly divided between activities that were undertaken entirely within our focal plant, and those that involved discussions with a customer or supplier. An example of the former was introduction of dry machining, which uses less coolant; an example of the latter was a plant which worked with its supplier to change the dimensions of the carpet rolls it received so that less would be wasted when the plant cut out floor mats. However, no firm that we interviewed made pollution prevention a systematic part of their product or process design.

We develop a framework to guide firms in their choice of pollution-control technique. (See figure 1 below.) This framework asks firms to assess themselves on two dimensions: the degree of environmental risk posed by their processes, and the strategic importance of those processes to the firm's success. If the process involves both low environmental liability and low strategic importance, little managerial action is needed. If it has high liability and is not core to the firm's strategy (such as metal coating for a manufacturer of fasteners) then outsourcing the process to a specialist is a good idea. If it has low liability and is strategically important, prevention is a very important tool. If the process is both high risk and highly

strategic (such as coating to a coating provider), the firm needs an integrated approach, involving all three types of pollution minimization mentioned above, plus cooperative prevention efforts with customers and suppliers, collaborative (not arm's-length) outsourcing, a systematic approach to waste management, linked environmental and production management, and environmental responsibility spread throughout the firm.

**Exhibit One: A Framework for Pollution Minimization**



We found that about half the firms were beginning to adopt the strategies recommended by the framework, although few had achieved high levels of performance. A particular weakness was lack of integration of environmental and production management.

Next, we looked at our other component of waste, unnecessary production effort. Using the 1993 US-Canada survey, we found that plants in Northeast Ohio significantly lag their rivals in many areas:

- they produced for their customers in larger batches (despite being located closer to them)
- they had older machinery and they were less likely to plan to buy computer-controlled equipment in the future

- their quality assurance methods involved less defect prevention
- they paid lower wages, trained their workers less, and had quality circles with a narrower scope of responsibility
- their relations with customers were more adversarial and involved less exchange of information
- their products were older and less complex

These results indicate that there is more wasted production effort in Northeast Ohio auto supplier plants than in their national rivals. For example, larger inventories mean that more floor space must be built, heated, and lit. Also, since the product sits around longer, it is more likely to become damaged or obsolete, and the root cause of defects becomes harder to find. Less-trained workers are less likely to be able to contribute waste-reduction ideas; lower-paid ones are less likely to be interested in doing so. More adversarial relations with customers complicates the adoption of pollution prevention ideas across the supply chain.

Our interviews three years later revealed some, but not a great deal, of progress in these areas. For example, only 17 of the 30 firms interviewed had evidence that they practiced statistical process control and root-cause analysis. Only nine had in place formal systems for employee training, suggestions, and profit-sharing. These results indicate that management at most firms has been slow to adopt continuous-improvement policies that are now seen as crucial to firm success. These results suggest that improvement of Northeast Ohio firms will depend heavily on increased training and education of management, as well as of shop-floor workers. A key issue for any type of performance improvement is being able to track results. Our interviews found very little ability on the part of firms to track the impact of their waste reduction efforts on costs.

We next examine whether extensive pollution-control efforts could be combined with effective production management. That is, is it possible for a firm to reduce both types of waste defined above simultaneously, or is there a trade-off between 'green' and 'lean'? We found a number of instances in which being lean actually helped firms be green (for example, preventing defects means less pollution is created), and only a few in which there was a conflict (responsiveness to customers can mean extra packaging or use of more toxic substances to create a more durable or esthetically pleasing part). In practice, however, we found no correlation at all between leanness and greenness.

Finally, we look at the effects of location on waste. As mentioned above, Northeast Ohio remains a center of automotive production. We found that this agglomeration reduces waste by reducing transportation cost. It has the potential to reduce waste even more, since geographic proximity should facilitate communication across the supply chain about ways to prevent waste. However, this potential was only rarely realized.

We draw on our analysis above to make a series of recommendations about policies which CAMP, Inc. might pursue. We recommended that the program pursue a team approach, one which combined CAMP experts in environmental engineering, production management, and performance measurement with their counterparts at local firms. Initially, these teams (which should include operators, who are closest to the production process) should focus on making integrated changes to a small area of the plant, so that results can be seen quickly.

## TABLE OF CONTENTS

- I. UP-TO-DATE DEFINITION OF WASTE AND PERFORMANCE EFFECTS OF WASTE -
- II. STUDY METHODOLOGY
  - Introduction
  - A. Companies Interviewed: Selection, Recruitment, and Data Collection
  - B. Companies Surveyed: Selection, Recruitment, and Data Collection
- III. BACKGROUND ON THE NORTHEAST OHIO AUTO SUPPLY CHAIN
  - A. A Large Source of Employment for Northeast Ohio
  - B. Sources of Environmental Pollution for Northeast Ohio
  - C. Examples of Supply Chains in Northeast Ohio
    - a. Metalworking
    - b. Aluminum Casting
    - c. Fastener Manufacturing
- IV. POLLUTION MINIMIZATION STRATEGIES AND PRACTICES IN THE NORTHEAST OHIO AUTO SUPPLY CHAIN
  - Introduction
  - A. Prevention
    - a. Machines and Process Changes
    - b. Reducing Raw Materials and Materials Substitution
    - c. Returnable Packaging
    - d. Factory Clean-up
  - B. Recycling or Reuse
    - a. Established Practices of Recycling and Reclaiming Scrap Metal and Oil/Coolants
    - b. Exemplary Case of Systematic Recycling Practice
  - C. End-of-Pipe Treatment

## V. ANALYSIS OF POLLUTION MINIMIZATION PRACTICES AND STRATEGIES

### Introduction

- A. Outline of Framework
  - a. Environmental Risk
  - b. Strategic Importance
- B. Laying out the Framework
  - a. Quadrant One: Low Risk, Low Strategic Importance
  - b. Quadrant Two: High Risk, Low Strategic Importance: Use Outsourcing to Mitigate Environmental Risk
  - c. Quadrant Three: Low Risk, High Strategic Importance: Use Prevention and Involve Customers and Suppliers
  - d. Quadrant Four: High Risk, High Strategic Importance: Use a Systematic Approach, Link Environmental Production and Management, and Distribute Environmental Responsibility
- C. Section Summary

## VI. PRODUCTION PRACTICES IN NORTHEAST OHIO: LEAN PRODUCTION AND ITS WASTE REDUCTION POTENTIAL

### A. State of the Northeast Ohio Auto Supply Industry Relative to the United States and Canada

#### Introduction

- a. Customer Relations
  - b. Production Methods
  - c. Quality Assurance
  - d. Work Force
  - e. Performance Measurement
  - f. Distinctiveness
- B. Is Lean Green?

## VII. How Firms in the Northeast Ohio Automotive Supply Chain Can Work More Effectively Together

## VIII. Recommendations

**APPENDICES**

- A. Types of Waste and Current Waste Reduction Activities
- B. Environmental Liability
- C. Certifications
- D. Pollution minimization in the Metal Finishing Industry: A Case Study



## OVERVIEW

This study was designed to help automotive suppliers reduce their wastes throughout the automotive supply chain. This study was sponsored by CAMP, Inc., the Case Western Reserve University Center for Regional Economic Issues, and the Organization for Economic Cooperation and Development (OECD).

The study aimed to assess trends in first-tier and second-tier supplier relationships in order to augment knowledge of the more frequently studied automaker/first tier relationships. The study attempted to ascertain how decisions about product and process design affected the amount of emissions and waste generated by the firms that constitute the backbone of the automotive supply chain in northeast Ohio.

This overview describes the structure and organization of the report. Chapter one introduces the study by describing its distinctive features and its relevance to current thinking about environmental control and waste reduction issues. Chapter two discusses in detail the methodology of the study and includes information about the selection and recruitment of participants as well as data collection. Chapter three offers background information about the automotive industry in Northeast Ohio.

The remaining chapters present results of the study and analyze their relevance to the northeast Ohio auto supply chain. Chapter four identifies the pollution minimization strategies practiced by companies in the region. This chapter relates many examples of waste and pollution prevention and control activities in the hopes that some might serve as models for other companies. Chapter five analyzes existing waste management practices and presents a framework that is both descriptive and prescriptive in nature. This framework advises that companies consider the environmental risk presented by a particular process or product in conjunction with the strategic importance it holds for the company. The framework also recommends specific waste management practices depending on the company's particular combination of environmental risk and strategic importance.

Chapter six turns to production practices among northeast Ohio auto suppliers. It addresses more fully than previous chapters the relevance of production practice and production management to pollution minimization and environmental management. In particular, this chapter examines lean production with respect to its waste reduction potential. The chapter ends with consideration of the question, "Can Green Be Lean?" Chapter seven focuses on the special case of the northeast Ohio agglomeration of auto suppliers. Drawing on examples from other regional industrial agglomerations, it suggests how companies in the study can take better advantage of the benefits of agglomeration and geography. Finally, Chapter eight summarizes the recommendations that derive from the study.

The study contains several appendices which further document our findings. We call particular attention to Appendix D, which is a case study of pollution minimization in the plating industry.

## CHAPTER I UP-TO-DATE DEFINITION OF WASTE AND PERFORMANCE EFFECTS OF WASTE

In the past, efforts to improve the environment focused on merely treating effluent waste, almost always in a manner that increased production costs. Increasingly however, efforts are directed toward preventing the generation of waste in the first place, in ways that actually reduce production cost. This newer view has led to a broader conception of waste, one that includes not only effluent waste, but also any type of resource use that results from unnecessary production. This newer view makes compatible the operations management goals of minimizing costs and maximizing quality with the environmental management goal of reducing emissions.

The study relied on the definition of waste articulated by Taichi Ohno, the architect of the Toyota Production System. Waste includes any activity which uses resources but does not create value, such as producing defective products, producing inventory and remaindered goods, processing steps which do not add to the product's functionality, movement of the product or of an employee which does not add to functionality, and waiting because an input was not delivered on time.<sup>1</sup> This definition of waste is consistent with the goal stated in a leading textbook on environmental management: "Every molecule entering a manufacturing facility should leave it as a component of a salable product".<sup>2</sup>

Each of these seven types of waste affects business performance in every industrial sector. Use of unnecessary raw materials, for example, adds not only to a firm's materials costs but also to its landfill or other disposal costs. Reducing the amount of raw material required to make a certain product will reduce both costs. Likewise, wasted motion used by employees may reduce the amount of product they can produce in a given time, and might also contribute to injury. All of these will ultimately cost the firm money. One final example might be poor plant layout, which would manifest itself in wasted time and motion transferring work in process from one location to another. Cell manufacturing and continuous flow processes can eliminate these wastes, and costs, from production.

Most importantly, this new approach to assessing waste in the business sector leads to the dual effects of reducing pollution and rendering businesses more effective and efficient. However, many of the benefits of pollution prevention cannot be achieved by firms acting in isolation from each other. For example, an unnecessary process step may be mandated by a firm's customer; a supplier cannot eliminate such a step without consultation. Assistance by organizations such as CAMP to help firms communicate about such issues will have significant public benefits, since waste leads to the fouling of the environment, and a reduced quality of life for citizens. The benefit to residents of a region from pollution prevention will

---

<sup>1</sup> James Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Simon and Schuster, 1996, p.13.

<sup>2</sup> T.E. Graedel and B.R. Allenby, *Industrial Ecology*. Englewood Cliffs, NJ: Prentice-Hall, 1995, p. 186.

be even greater if the customers and suppliers are located in the same region. Therefore, it is firmly within the interests of a geographic region, such as northeast Ohio, and indeed of society as a whole, to adopt this new framework for assessing and reducing all types of wastes.

Reflecting this approach, in this study we will use the term 'waste' to describe all types of resource use which do not add value to a product. We divide waste into two categories: 'pollution', which refers to unwanted substances emitted into the environment, and 'unnecessary production effort', which leads directly to wasted human effort and indirectly to additional pollution.

The distinctive feature of this study is its focus on the automotive supply chain, that is, relationships between customers and suppliers. Academic and industrial studies like this one often concentrate on firms of a particular type or size. Individual firms interested in addressing the issue of waste reduction necessarily focus on their own operations, from inputs to products and waste streams. By contrast, this study directs its attention to a group of companies whose common feature is neither similar structure nor similar products or processes. Instead, they represent the northeast Ohio automotive supply chain. Indeed, many companies that were interviewed for the study supply other companies also interviewed, so that the data set consists largely of overlapping supply chains, which the study results suggest are highly representative of the region in general. By investigating waste in an integrated manner, we hope to identify waste prevention opportunities that would be invisible if the companies were investigated individually or grouped by type of product manufactured.

By "automotive supply chain" we mean the set of firms which use each other's products to produce a car. (For examples of automotive supply chains in Northeast Ohio, see Exhibit 3.1 in Chapter three.)<sup>3</sup> The nature of relations among firms in a supply chain will have an important impact on how much of the potential for pollution prevention is realized. This is particularly true in the auto industry, where almost all parts are custom-designed for one particular line of cars because their functioning is so interdependent.<sup>4</sup> Especially in this case, therefore, firms will be more likely to reap the benefits of prevention if they have good channels for communicating ideas about product or process improvements, and well-developed mechanisms for sharing the returns to investments in such improvements, than if relationships are arm's length and short-term.<sup>5</sup>

---

<sup>3</sup> Even though they do not supply a product which ends up on a car, we included 2 waste disposal firms in our study because of their important impact on firms' pollution minimization practices and performance.

<sup>4</sup> For example, Chrysler found on one model that changing the angle of the rear window affected the design of the engine compartment. The reason is that the proposed new window required more energy to defrost, requiring a more powerful, and therefore larger, motor to provide it. See CAMP, Inc. *Works in Progress*, Winter 1997.

<sup>5</sup> For more on this topic, see Chapter 6 of this report and Susan Helper and Mari Sako, "Supplier Relations in Japan and the United States: Are They Converging?", *Sloan Management Review*, Spring 1995.

## CHAPTER II STUDY METHODOLOGY

### Introduction

Data for the study came from two sources. The first was a series of interviews conducted in summer and fall of 1996, designed especially for this study. The second source was two written questionnaire surveys conducted in spring and summer 1993 by Susan Helper, Associate Professor and Research Associate of the Center for Regional Economic Issues, Case Western Reserve University. This section describes the selection and recruitment of companies and gives background information on data collection procedures.

### A. Companies Interviewed: Selection, Recruitment, and Data Collection

Many studies of the automotive industry concentrate attention on the Big Three and their first tier suppliers. The goal of the CAMP project, entitled Pollution Prevention Assistance in Automotive Supply Chain, was to focus on the lower tiers of automotive suppliers. Thus, this study also targeted lower tier suppliers.

Three sources provided names of companies to be contacted for the study. One source was a list provided by CAMP of Northeast Ohio firms in SIC (Standard Industrial Classification) 34 and 35 (manufacturers of electrical and mechanical equipment). Second was the Elm Guide to Automotive Sourcing (available from Elm, Inc. in East Lansing, Michigan). This guide lists the major first-tier suppliers (both domestic and foreign-owned) to manufacturers of cars and light trucks in the United States and Canada. For the purposes of recruiting companies in this region, the list was restricted by selecting only those firms in telephone area codes 216 (Cleveland) and 330 (Akron). A third, and very important, source of companies to contact came from suggestions solicited from interviewees of their own customers and suppliers. These suggestions permitted the targeted completion of supply chains. The following section describes the sample selection procedures. We conclude that the group of companies interviewed provides a representative sample of automotive suppliers in Northeast Ohio.

Contacting companies involved preliminary phone calls briefly describing the project and requesting permission to fax a one-page description of the study. Follow-up phone calls aimed to either schedule interviews or determine a company's unwillingness to participate. At each plant that agreed to participate, we administered a structured questionnaire. All participants were promised confidentiality. In all cases we interviewed at least two people per plant (usually a production manager and an environmental manager) and had an extensive plant tour. In the course of the study, we conducted more than 70 interviews. In some cases, we were accompanied by an environmental engineer from CAMP.

The potential pool of establishments to interview, garnered from the above-named sources, numbered 359. We called every establishment on the Elm list, and randomly selected firms from the SIC lists. (We use the term establishment because some firms have multiple plants in this area.) Of the 142 establishments contacted, 57 either no longer supplied the automotive industry or had never done so. (The majority of the non-automotive suppliers came from the SIC lists.)

Leaving aside the 57 non-automotive suppliers, the potential pool of companies for the study was 302. Of these, 85 (27%) were contacted and 30 were interviewed. This meant that 35% of those contacted agreed to be interviewed. Establishments that refused an interview outright numbered 24, while 33 never responded to the request for an interview.

The highest success rate came from the 11 companies whose names were provided by other interviewees. Almost half of this group (45%) agreed to participate in the study. In at least one instance, an establishment that initially declined to participate later agreed to do so when a researcher called with a reference from another subsidiary of the same firm.

The response rate of 35% would have been high for a postal survey requiring 20-30 minutes to fill out. It is quite remarkable for a study which required a 2-3 hour interview of at least two people in the firm. These facts have two important implications: first, that there is a great deal of interest in the subject of pollution prevention, and second, that the sample can be considered representative of auto suppliers in Northeast Ohio.

However, one important caveat is that most of the referred companies that refused to participate were plating companies. Although some of the study participants do sell plating and finishing, the number of electroplaters was low in comparison to those who use less environmentally-damaging finishing methods. Thus, it seems likely that electro-plating companies are slightly underrepresented in the data set.<sup>6</sup> Another almost absent category of automotive supplier is injection molders. Although several companies that make rubber products agreed to participate, no plastic injection molding companies agreed to participate. With the exception of injection molding and plating, however, this data set represents a cross-section of the northeast Ohio automotive supply industry. Certainly metal-forming companies, a major regional industry, are well represented in the data set.

Not all of the supplier firms interviewed delivered directly to one of the automakers' plants; some represented lower tiers (that is, they supplied to firms who in turn supplied the automakers). In contrast to the specialized structure characteristic of the Japanese auto industry<sup>7</sup>, only seven of the thirty firms reported that they occupied only one tier. One materials processor we interviewed acted as a first, second, third and fourth-tier supplier. Overall, we interviewed 11 firms which categorized themselves as primarily first-tier, seven who were primarily second-tier, four who were primarily third tier, and seven who provided specialized services to the industry (such as steel processing, or metal finishing).

In addition, a variety of personnel at automotive assemblers were interviewed by Helper as part of her on-going research on the automotive industry, though not specifically for this project. These individuals included purchasing and materials management managers, plant managers, design engineers, and line workers at Ford's Ohio Assembly Plant in Avon Lake,

---

<sup>6</sup> To remedy this, we did a case study of the plating industry based on a variety of other sources. See Appendix D.

<sup>7</sup> See Toshihiro Nishiguchi, *Strategic Industrial Sourcing: the Japanese Advantage*. Oxford: Oxford University Press, 1994.

Ford's Cleveland Engine Plant #2, General Motors's assembly plant in Lordstown, Ohio, General Motors Delphi Packard Electric, and Honda of America in Marysville, Ohio.

## **B. Companies Surveyed: Selection, Recruitment, and Data Collection**

The second source of data used in this report is two surveys of automotive suppliers conducted by Helper in spring and summer 1993. These surveys were sponsored by the MIT International Motor Vehicle Program and the CWRU Center for Regional Economic Issues. The first survey was sent to the divisional director of sales and marketing at automotive suppliers in the United States and Canada. The focus of this survey was information about relationships with customers, and product characteristics. The second survey was sent to plant managers, and asked about operations policies and relationships with workers. Because many companies supply their customers with several different types of products, and their relationships with their customers differ by product, respondents were asked to answer the questionnaire for their most important customer regarding one product which was typical of their company's output and with which they were familiar.

Both the plant manager survey and the marketing director survey were administered in Europe by Dr. Mari Sako of the London School of Economics; she also administered the marketing director survey in Japan. Many of the questions were taken from an earlier survey undertaken by Helper in North America in 1989 and a short questionnaire on trust and opportunism administered by Sako in the electronics industry in Japan and Britain in 1988-9. In addition, questionnaires were piloted at a handful of supplier companies in the USA and Japan during 1992. As a result, improvements were made to the clarity of questions and the ease of answering them. Much attention was paid to the phrasing of questions in a vocabulary familiar to managers, and to the consistency of meaning in the English and Japanese languages. For instance we asked several people to translate some questions from English to Japanese and others to translate them back from Japanese into English. The process of piloting and revision took around nine months.

The sample chosen for the North American questionnaire was every automotive supplier and automaker component division named in the Elm Guide to Automotive Sourcing (available from Elm, Inc. in East Lansing, Michigan). This guide lists the major first-tier suppliers (both domestic and foreign-owned) to manufacturers of cars and light trucks in the United States and Canada. Each respondent who hadn't yet responded to the survey received three mailings over the course of 2 ½ months.

The responses were far above the norm for business surveys. The response rate was 55% for the sales manager survey, after taking into account those firms which were unreachable (the surveys sent to them were returned undelivered), and those which were not eligible to answer the survey (they were not first-tier automotive suppliers, or they specialized in supplying for heavy truck and buses). For the plant manager survey, the response rate was 30%.

The respondents to each survey are quite representative of the US population in terms of size of firm and location, as compared with data from the Elm Guide and from County Business Patterns for SICs 3714 (automotive parts) and 3496 (automotive stampings). However, vertically integrated business units of the automakers were under represented.

## CHAPTER III

### BACKGROUND ON THE NORTHEAST OHIO AUTO SUPPLY CHAIN

#### A Large Source of Employment for Northeast Ohio

The auto industry is often called the 'industry of industries', since so many different materials and manufacturing processes contribute to the production of a car: steel, plastics, rubber, and glass are stamped, machined, welded, molded, cast and assembled.

Northeast Ohio has been a center of automotive production since before the days of Henry Ford. Many of the nation's large automotive suppliers were founded in the area in the early years of this century, such as Cleveland Cap Screw (now TRW), Eaton, Timken, and Packard Electric (now part of General Motors).

Northeast Ohio has remained important for the industry, although less so than in the past. In 1974, Cuyahoga County by itself accounted for 4% of the nation's automotive employment, with almost 30,000 workers.<sup>8</sup> Thirteen Northeast Ohio counties (which are today encompassed by the area codes 216 and 330) accounted for 11%, or 60,000 workers.

By 1993, total US automotive employment had increased slightly, from 710,000 to almost 750,000. However, Northeast Ohio's employment had fallen sharply, to less than 34,000. Almost all of this job loss was concentrated in Cuyahoga County (where Cleveland is located). Cleveland lost half of its automotive jobs in just the ten years between 1974 and 1984. By 1993, fewer than 13,000 workers were employed in the industry.

As we will explore further in Section C and in Chapter VII, the supply chains in which Northeast Ohio auto-parts firms are involved are both local (many firms have their suppliers and customers within a few hours' drive) and international.

---

<sup>8</sup> We define the automotive sector as the standard industrial classifications 3465 (automotive stamping), 3711 (automotive assembly), and 3714 (automotive parts). The thirteen counties are Ashtabula, Carroll, Columbiana, Cuyahoga, Geauga, Lake, Lorain, Mahoning, Medina, Portage, Stark, Summit, and Trumbull. In both 1974 and 1993, about 90% of automotive employment was located in Cuyahoga, Trumbull, Summit, and Lorain Counties. Data in this section comes from the US Bureau of the Census, County Business Patterns; 1993 is the latest year available.

## B. Sources of Environmental Pollution for Northeast Ohio

The auto industry is a significant source of pollution in Northeast Ohio. At least twelve plants supplying the auto industry were listed in the 1994 Toxic Release Inventory<sup>9</sup> as having the largest toxic releases in the region of chemicals such as manganese, zinc, hydrochloric acid, sulfuric acid and methane. (We conducted interviews at four of these firms.) The most common wastes in the northeast Ohio auto supply chain are scrap metal, oils, and coolants. Other major pollutants include sludge (usually containing base metals), chemicals and solvents, inert solid waste (rejects and trash), and air emissions. Many of the companies interviewed have waste water treatment systems. The following chapter provides more detail on the types of pollutants and the current waste reduction and disposal practices of companies in the regional auto supply chain.

In one case, plant management stated that they did not have any waste. However, at our plant visit we observed trash, broken pallets, scrap metal and plastic, and wasted time. Identifying such wastes is the first step to reducing them.

The following types of waste are produced by the 30 Northeast Ohio auto suppliers interviewed:

SOLID		LIQUID	
Garbage/rejects	6	Oils/Coolants	12
Broken pallets	3	Sludge; base metals	10
Corrugated boxes	2	Chemicals/solvents	10
Bags (chems/clay)	1	--from cleaning	2
Scrap metal; flash	16	--from prod. process	2
Scrim/Rubber	2		
Plastic/teflon	2	AIR	
Barrels (metal)	1	Emissions	7
TIME (poor layout)	3	None mentioned	1

## C. Examples of Supply Chains in Northeast Ohio

---

<sup>9</sup> Reprinted in the newsletter *Ecocity Cleveland*, April 1996, pp. 6-11.



The data analyzed in this report comprehensively represents several supply chains in three regional industrial clusters. This section describes the chains without identifying companies. The three industries are metalworking, aluminum casting, and fastener manufacturing. (See exhibit 3.1.)

#### **a. Metalworking**

*Number of plants visited:* 5. Total employment at visited plants: 820. This cluster consists of firms which provide services such as stamping, metal finishing, machining, and heat treating.

*Description of Cluster.* Firms in the metalworking industries tend to be labor-intensive and non-specialized. Their competitors, suppliers, and customers are usually local or regional.

Company A is a metal finisher with many national locations. Its facility provides several kinds of anti-corrosion coating: electrodeposition, or "e-coating," powder coating, mainly for non-automotive purposes; and a patented coating which they apply under license. Company A has about sixty customers, nearly all local. Their most distant (and one of their biggest) is Company X, in Buffalo, a first-tier supplier to GM. Except for Company X, their customer base is local because transportation costs are high relative to value-added; this is a general characteristic of the plating and surface-finishing industry. In fact, one large stamper (not interviewed) built its plant a few miles from Company A to minimize transportation costs. Company D and Company E are also important customers.

Company B is a heat-treater. Their important customers include Company C, Company X in Buffalo, and Honda in Anna, OH. Heat treating at Company B is an important intermediate process step for Company C.

Company C-1 is a unit of Company C. The factory (C-1) does not operate as a separate profit center, but is a central machining facility (almost exclusively CNC turning of transmission shafts) for a nearby plant, C-2. Plant C-2 buys steel from local producers and forges the steel into rough shafts. Company B then heat-treats the shafts and sends them to Company C-1's turning facility. This facility has also worked closely with its nearby supplier of cutting tools to reduce machining costs. Company C-1 ships finished transmission shafts directly to customers; largest customers include Saturn in Spring Hill, TN, and New Venture Gear in Syracuse, NY, and Muncie, IN.

Company D is a stamping plant that makes a variety of products for the automotive and mining industries. The firm is technically sophisticated and uses newer design and production technologies like finite element analysis, computer drafting, coordinate measuring machines. Ford is the company's largest customer, and they ship to US and overseas Ford facilities. Company D's biggest inputs are steel and metal finishing. Several Cleveland-area firms supply plating and coating services, including Company A. Company D also works closely with another local zinc plater (not interviewed), whom Company D helped get started in business about a decade ago.

The steel is usually from warehouses and service centers, so Company D has quite limited contact with the steel manufacturer. For high-quality or specially-cut steel, Company D turns to Company Y, a steel service center in Columbus. However, according to Y's marketing

director, Y can't compete with Cleveland-area firms on commodity products. These firms have lower transportation costs. Company Y buys much of its steel from Company Z, and then re-rolls it to greater precision, or cuts it to dimensions specified by the customer.<sup>10</sup>

Company E manufactures brake hub and rotor assemblies for GM and Ford pickup trucks and vans. They purchase rough rotor and hub castings from a foundry in Wisconsin. Rotor castings are shipped to Company A for anticorrosion coating and electrodeposition coating (hub castings are painted in-house). Company A is an important supplier because it is one of the only firms licensed to apply the anticorrosion coating that the customer specifies. Company E machines and assembles the hubs and rotors, then ships the finished assemblies to Ford and GM's Delphi Division in Saginaw, MI.

Other important local firms in this cluster were mentioned above, but not visited. These include a stamper that works closely with Company A; a zinc plater that provides important services to Company D; and the C-2 facility of Company C, for which the location interviewed performs machining. Two firms not located in Northeast Ohio, but which are important parts of this cluster, are Company X in Buffalo (not visited), which gets heat-treating services from Company B and anticorrosion coating from Company A; and the company that holds the license for the anticorrosion coating used by Company A on parts shipped to Company E.

*Viability of Cluster.* Auto assemblers and first-tier suppliers have moved in the last several years to outsource manufacturing processes like surface finishing and heat treating. There are three reasons for this tendency to subcontract these activities: (1) the high capital and operating costs of the equipment, especially when not used at full capacity; (2) high energy costs of plating, coating, and heat treating; and (3) costly health, safety, and environmental regulations. The last is especially important in the plating and surface finishing sector. The US Environmental Protection Agency (EPA) and Occupational Safety and Health Agency (OSHA) have tightened emission and exposure limits (and are continuing to do so) for process chemicals and byproducts in plating and coating. While the last two costs would be borne by both manufacturers who perform their own surface finishing and heat treating and those who outsource those activities, there exist increasing returns to specialization which more than offset the extra costs incurred in outsourcing (longer lead times, packaging, shipping, etc.).

Nationally, the surface finishing industry employs about 100,000 people in over 3000 shops. Total annual shipments are over \$4 billion, and auto parts make up the largest market segment, followed by consumer durables and defense. The average shop employs about 30, is capitalized at about \$400,000, and takes in about \$800,000 in annual revenue. Sales revenue has increased about 5% to 6% annually for the last several years and will probably continue to do so until the end of the decade. The number of shops has also increased. Two factors account for this growth: the continuing trend toward outsourcing surface finishing operations, and strong demand for corrosion-resistant components. However, total employment has dropped by about 20% since 1993. According to the Ohio Association of

---

<sup>10</sup> For information on steel service centers, see "Adding Value and Luster to Plain Steel", Claudia Deutsch, *New York Times*, October 15, 1996, p. D1.

Metal Finishers, there are some 175 to 200 metal finishers in the northern Ohio area (including Toledo, Sandusky, and Youngstown). Northern Ohio contains the nation's fourth or fifth largest concentration of metal finishers. (See Appendix D for more detail.)

The trend toward outsourcing coupled with stricter regulation suggests that firms in this industry have enlarged their sales revenues and customer bases, while their operating costs have also increased significantly. Company A seems to bear out this trend: its sales have gone up considerably in the past five years, and its margins are healthy. But the firm works constantly to reduce costs by improving quality, efficiency, cycle times, environmental performance, and the like. While the firm is not unionized and actively seeks to hold down labor costs, it claims to pay better wages than its local competitors.

The heat treating, stamping, and machining industries have not been affected by environmental and occupational regulations to the extent that surface finishing has. Company B has grown significantly in the past decade. Company D has been producing stampings for the auto industry for about 15 years. The firm has enjoyed steady sales growth and has managed to keep unit costs and profit margins fairly constant. Company C-1 has roughly doubled its output and increased its workforce by about 60% in the past three years. Its costs for cutting tools and coolant have risen about 5% to 7% total in this period. It is difficult to get profitability estimates because it is not a separate profit center, but is a machining facility for another location.

Company E is a first-tier supplier of brake rotor and hub assemblies. The plant seems to have sole-source life-of-model agreements for some models and their plant is running at capacity.

In sum, sales revenues in this cluster are increasing, but profitability, employment, and wages have not kept pace with this growth. Firms in this cluster derive significant competitive advantage from their location in Northeast Ohio; they will almost certainly remain in the region.

## **b. Aluminum Casting**

*Number of plants visited:* 5. Total employment at visited plants: 679. First-tier firms in this cluster produce aluminum components for engines, transmissions, and exhaust systems. One second-tier firm provides a product that lubricates the casting dies. Another supplies molten aluminum to casters.

*Description of Cluster.* These firms, except for the manufacturer of lubricating product tend to be capital intensive. Except for the supplier of molten aluminum, firms in this cluster have a geographically widespread customer base, selling nationally and internationally.

Company H is a small, family owned firm that invented and now manufactures a lubricant that lines casting dies and helps reduce friction in the plunging mechanism. The firm has sold to its major customers, Company J, Company K, and General Motors in Kokomo, Indiana, for about five years. Recently, it has expanded into the European and Pacific Rim markets. Until recently, the patent on the product gave the firm a clear competitive advantage. Now,

however, it is litigating against other companies trying to infringe on the product line. The firm's suppliers of proprietary chemical raw materials are all located out of state. While the company has an international customer and supplier base, it is firmly embedded in this regional cluster because of its especially close relationship to Company J and Company K. These facilities, as well as another, smaller casting company (not interviewed), provided valuable assistance when the owner of the firm developed this product. These local aluminum casters remain important customers.

Company I, headquartered in Indiana, produces molten aluminum in six plants in the Midwest and South. All of their customers, aluminum casters, are located within several hours' drive from the plants, because the pots of molten aluminum are delivered by special truck and must arrive still at molten temperature. Major customers for the Cleveland smelting plant include Company J, Company K, and GM Powertrain in Toledo. Suppliers are mostly east coast scrap dealers.

Company J is a division of a large company that has been at this location for over fifty years. The parent company has 42 plants in North America, of which four are diecasting plants, two located in the Cleveland area. Company J is a first-tier supplier of precision aluminum castings used in automotive transmissions. Its two most important suppliers are Company I and Company H. Company I delivers molten aluminum several times a day, and the two firms collaborate on quality issues. Nearly all of Company J's business is with Ford and GM plants in Ohio and Michigan. Its competitors include one Cleveland facility and another in Toledo (neither was interviewed), but Company J believes that it enjoys a competitive advantage over them because of its engineering expertise and precision production methods. The plant works closely with the parent company's nearby engineering offices for this technical support. The corporate engineering offices help formulate designs with Ford and GM and assists in the design of dies.

Company K is a sister facility for Company J. It is a new plant which began production in 1993. It manufactures transmission valve bodies, almost exclusively for GM locations in Toledo, Warren, and Windsor, Ontario. Important suppliers are Company I, which delivers molten aluminum; Company H, which supplies a lubricant; and a company that sells ball shot used to deburr and stress-relieve the castings (not interviewed). Company K's major competitors are one company in Toledo and another in Kentucky.

Company L is one of 27 plants in 10 states owned by the parent company. Company L bought this plant in 1991. This facility produces aluminum engine components for GM and Ford locations in the Detroit area. It relies upon a proprietary brazing technique to give it an advantage over its Ohio and Michigan competitors. It obtains aluminum mostly from its parent company's smelting plants.

*Viability of Cluster.* The demand for aluminum automotive parts is growing. But the viability and prospects of the Northeast Ohio cluster have not matched this growth. This study found instead that first-tier suppliers in this cluster are stagnant or declining. Second-tier firms fared better.

Of the three first-tier facilities investigated, Company J and Company K were stable and slightly growing. Company J reported that their business has expanded because of increased use of aluminum castings in transmissions. The plant has very good capacity utilization

figures and has significantly reduced work-in-process inventory in the past three years. Yet employment has dropped by about a quarter, and although the plant has increased resources and time for employee training, it has drastically reduced attendance at professional meetings. An important reason for these reductions is the startup of Company K in 1993, which began producing similar parts. The parent company built Company K because Company J no longer had space for expansion. Further, the number of employees hired into the new plant has more than offset reductions in force at Company J. Company L has experienced a more drastic restructuring. Its plant is the result of a consolidation of three facilities in northeast Ohio in the past three years. The firm has downsized its area operations because of weak profits, loss of an important automotive customer, and the elimination of some mainstay products.

The two second-tier firms appeared to be healthy. Company I has increased its output by about 30% in the past decade, and has achieved significant productivity gains in the past three years. Its shipments and profits have also risen in the past three years; the plant is presently at or near full capacity utilization. Company H reported steady to explosive sales growth over the past five years, with comparable increases in profits.

### **c. Fastener Manufacturing**

*Number of plants visited:* 3. Total employment at visited plants: 963. Two of these are first-tier suppliers of fasteners, and the third provides coatings and sealants for fasteners.

*Description of Cluster.* This cluster is similar in many respects to the metalworking cluster described above. Firms in both clusters use the services of platers, coaters, and heat treaters. Although our interviews revealed only limited connections between companies across cluster boundaries, further investigation may discover closer ties between the clusters.

Company P adds coatings and sealants to fasteners. The company has a diverse customer base throughout the Midwest and is not dependent upon a few large customers. Nearly all of its customers are auto suppliers. Important customers include Company Q and Company R. Its major suppliers are chemical companies that supply process chemicals.

Company Q manufactures specialty cold-forged fasteners and nuts. Most of their business is automotive, and they act as a first-tier and second-tier supplier. As a first-tier supplier, the company ships to nearby locations in Canada, Michigan, and Ohio. It has a national customer base for its second-tier business, but some important customers, like Eaton and TRW, are local. The company claims to have few competitors because of the specialized nature of its products and processes. Almost all of its suppliers are located in the Cleveland area. Important suppliers include Company P, which provides coating services; Company U, which zinc-plates fasteners for some of Company Q's customers; Company V, which anneals fasteners; and Company T, which ships steel and wire to Company Q. Company W is also an important steel supplier. The interviewees stressed that they work closely with their platers and heat-treaters to improve quality and lead times; Company Q has a metallurgist on site at Company V. Company Q used to do its own zinc plating, but outsourced it to Company U because of the expense of waste disposal. Interestingly, Company V and Company U are located next to one another.

Company R is a producer of high-performance commodity fasteners with two divisions under the same roof, one that supplies the auto industry and another that sells to the off-road, truck, and heavy-equipment industries. The Ford Engine Plant in Brookpark is one of the firm's largest customers. Other Ford, GM and Chrysler plants make up the rest of the company's automotive business. Company R competes in the global marketplace: some of its competitors are local, like Company Q; others are national. But it has been experiencing stiff competition from imports in the last several years. Important suppliers include Company P for coating and Company U for plating services. Company R purchases its wire from one company in Minnesota and also from Company S. Company R does its own heat-treating in house.

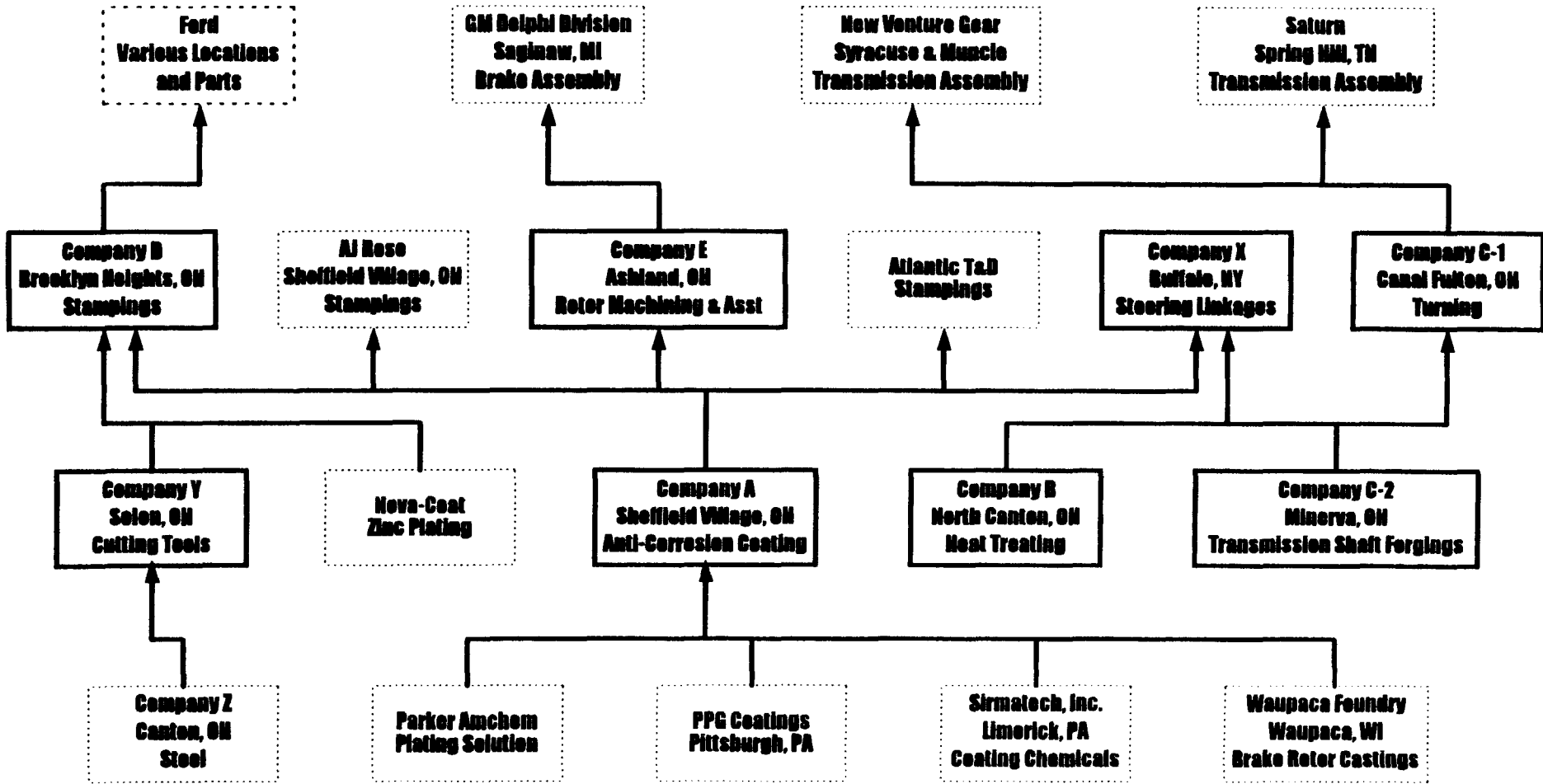
Important local firms in this cluster which were not visited include two suppliers of steel and wire: Company S, which supplies wire to Company R, and Company T, which ships to Company Q. Company U, located next door to both Company R and Company V, provides zinc and nickel plating for both fastener firms (Company Q and Company R). Company V performs heat treating for Company Q.

*Viability of Cluster.* According to Frank Akstens of the Industrial Fastener Institute, a trade organization located in Cleveland, there are about 400 fastener firms in the United States. Total annual shipments are about \$5.5 billion, and average about \$12 million per firm. The two largest fastener companies in the US are Textron, with about 20 plants nationwide, and Illinois Tool Works, with about 13 plants. These two firms combined account for about 20% of the market. No other firm has above a 5% market share. About one-quarter of the industry's volume, about \$1.4 billion, is automotive; there are about 2600 fasteners in a typical car.

Cleveland is one of the top five geographic concentrations of the fastener industry. The area provides ready access to ancillary firms like platers, coaters, heat treaters, and steel and wire suppliers. Northeast Ohio is also accessible to auto plants in Ohio, Michigan, the Upper South, and Ontario. Based on our interviews at firms in this cluster, the Cleveland fastener industry is a permanent fixture of the local economy. Individual firms have been in business at the same location for decades: Company Q has been in its current location in one form or another since 1880, and Company R has remained in its facility since the mid-1950s. Company P, the largest employer in the town in which it is located, has occupied its plant for about twenty years. All three firms seem strongly tied into the Northeast Ohio auto supply industry.

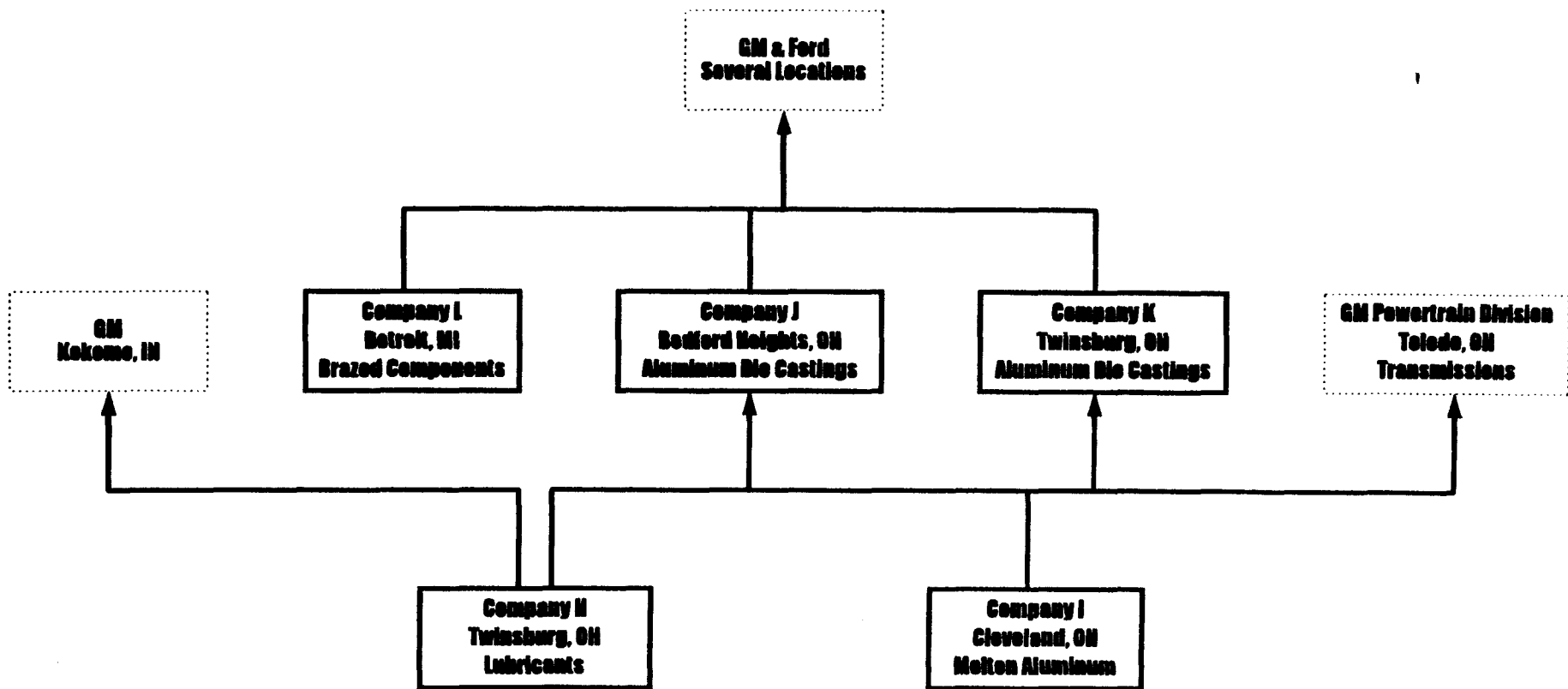
The Cleveland fastener industry also enjoys a stable customer base. Both fastener producers claimed to have decades-old and ongoing relationships with key customers. Company P claimed to have fairly long-term and stable relationships with customers, but with some degree of uncertainty. They seek a diverse customer base to smooth out this uncertainty. Both Company R and Company P have experienced moderate and steady sales growth over the past three years. Company R roughly doubled its workforce over the last three to five years. Company P expanded their plant in several stages over the last twenty or so years. Company Q reported a decline in sales and a three-quarter reduction in its workforce since 1980. This drop in sales and employment is partly due to a restructuring of the parent corporation, which limited the plant's product line, and to heavy capital investment in the plant.

### Exhibit 3.1a Metalworking Supply Chain



= Visited  
 = Not Visited

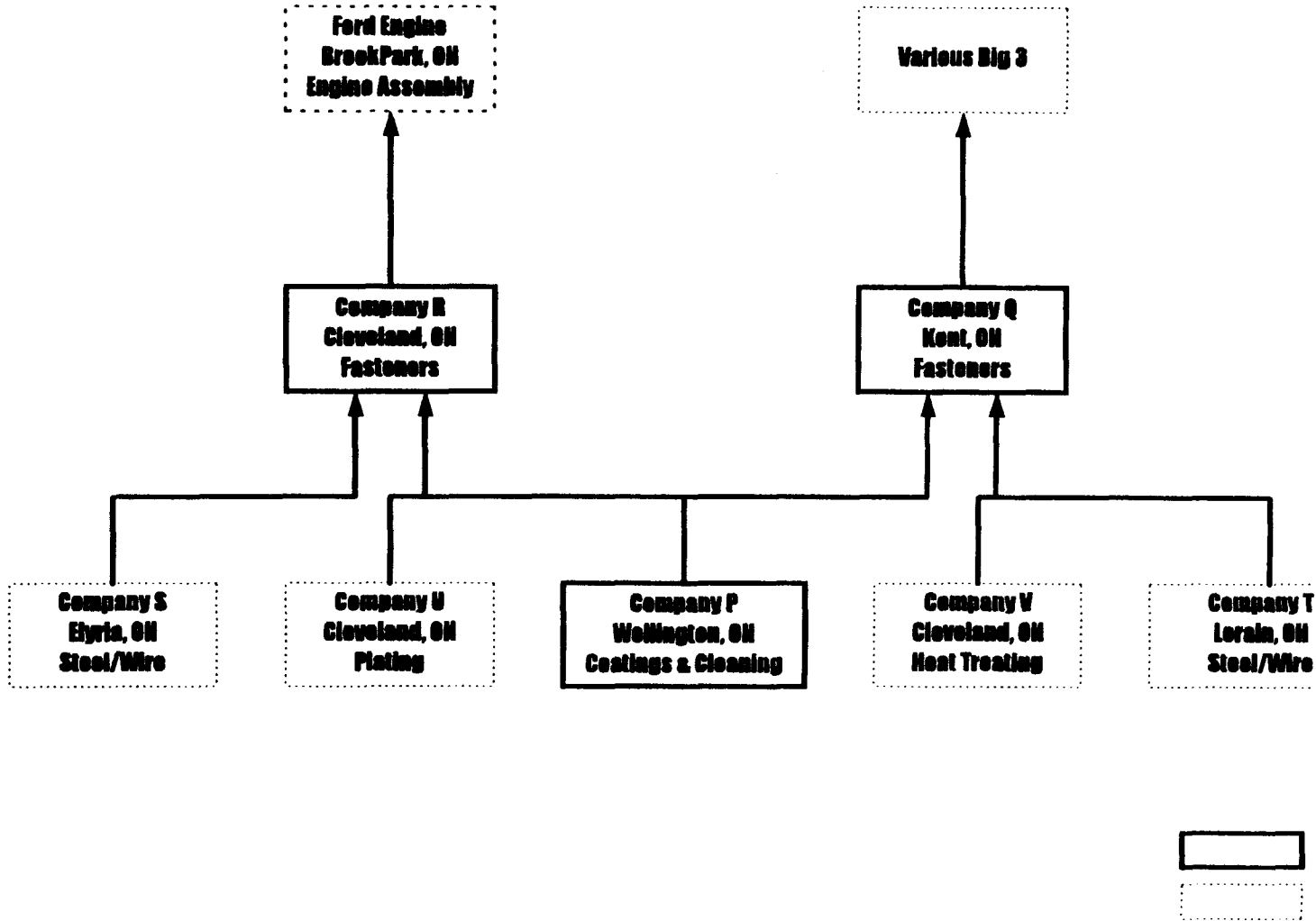
**Exhibit 3.1b: Aluminum Supply Chain**



**[Solid Box]** = Visited  
**[Dashed Box]** = Not Visited



### Exhibit 3.1c: Fastener Supply Chain



## **CHAPTER IV. POLLUTION MINIMIZATION STRATEGIES AND PRACTICES IN THE NORTHEAST OHIO AUTO SUPPLY CHAIN**

### **Introduction**

This section describes our interview data with respect to three mechanisms for pollution minimization. Eleven of the 30 companies (37%) provided examples of pollution prevention. Fifteen companies (50%) reuse and/or recycle materials. (It was unfortunately not possible to distinguish clearly between these two options.) The majority of companies, (21, or 70%) have in place end-of-pipe treatment.

Three companies gave no examples of either pollution prevention or waste reduction or treatment activities. Of these, two are assembly factories whose waste consists principally of trash. The other has minimal material waste, although poor plant layout due to old age of the facility translates into wasted time and internal transportation.

This section describes the range of activities in each category. Later chapters of the report analyze the results of this section in comparison with other variables.

### **A. Prevention**

Eleven companies gave examples of pollution prevention. These activities, however, were in general not systematically carried out; many of the companies gave only one example of an action that they had undertaken which had prevented pollution.

Of the eleven plants, 6 also engaged in recycling and/or reusing wastes and 6 have in place end-of-pipe treatments. About two-thirds of this group (7 of 11) have low environmental liability. Instead of being motivated by environmental regulations, most of the companies that have programs to prevent waste are driven by economic incentives, such as reducing landfill costs.

This section describes the kinds of waste and pollution prevention activities undertaken by these companies. It is hoped that some of these might serve as examples that could be implemented elsewhere in northeast Ohio.

#### **a. Machine and Process Changes**

In five cases, prevention activities consisted of the substitution for older machines of improved machinery or the institution of processes that generate less waste. One company instituted "dry" machining, which uses less coolant. Another installed machines that recaptured coolant and lubricants for reuse. Three switched to an aqueous system for degreasing. And one company, a new state-of-the-art facility, invested in numerous such machines, including replacing quench tanks with forced air for cooling, thus reducing water usage. A steel

producer was able to increase the usable width of its product through better process control and more careful packaging to avoid damage to the edges of the roll of steel.

Two companies in the data set mentioned recent switches to aqueous systems for production steps or de-greasing. Both cited environmental compliance as a benefit of the new systems. One got into aqueous cleaning (from previous vapor degreasing) about 5 years ago. This company learned about the new technology from trade journals, and adopted it because they sensed that the regulatory environment was heading in that direction, following the lead of "bigger plants". Another company switched to a water-based epoxy because of a company policy of environmental concern.

The company that has replaced half of their machining tools to "dry" machining likewise cited environmental motivations for doing so. Their two major waste streams are metal chips, which they recycle, and machine tool coolant. However, it appears that the plant has not completely gained control of the new process of dry machining. The interviewer observed many boxes of parts for scrap or rework, and line's yield is only 87%. In addition, the health and safety manager expressed concern that dry machining "causes chips to fly around more", potentially leading to more eye injuries.

#### **b. Reducing Raw Materials and Materials Substitution**

Five companies sought to reduce the amount of raw materials used. Companies that use rubber as a raw material seem particularly motivated to engage in this kind of waste prevention, given the difficulty of recycling or reusing the waste and the cost of landfill disposal. A manufacturer of floor mats engages in routine redesign of products to attempt to reduce the amount of raw materials used. The same company also worked with one of their suppliers (a parent company) to change the dimensions of carpet rolls, which allowed them to cut more mats with less waste from the same amount of material.

Two companies trying to reduce raw material use worked with suppliers to accomplish this. One sought its suppliers' help reducing its use of oil and coolants, while the other looked for a supplier of thinner lubricant. A supplier of surface finishing worked closely with their supplier of paint to produce a low pollution paint that contained no hazardous materials (no chrome, lead, or volatile organic chemicals). One company described working with a customer to replace a spec for high salt spray resistance for an interior part with a lower resistance spec. The result was cheaper, used less environmentally-harmful materials, and could be done in-house, thus also eliminating extra transportation.

#### **c. Returnable packaging**

Although use of returnable packaging by itself was not sufficient to place a company in the "pollution prevention" category, this activity is discussed briefly in this section. Five companies specifically mentioned the use of returnable packaging as a waste reduction effort. The number of companies using returnable packaging could well be higher. However, since

the customer dictates the type of packaging, efforts to reduce waste by increasing the use of returnable packaging would require addressing customers, not the lower tier suppliers.

-

#### **d. Factory Clean-up**

Several interviewees asserted that clean factories produced fewer rejects and less waste than disorganized, messy-production areas. At one aluminum casting facility, an interviewee pointed to piles of flash, metal scraps, oil, dust, and water around the machines. He argued that a cleaner factory would run more efficiently, but stated that production engineers will not take the necessary steps to clean up the production floor. Part of the problem is structural, since many very heavy machines are located so close together that it is difficult to clean between them. The newer of the two aluminum casting facilities was much cleaner.

The assertion that a cleaner factory floor would improve productivity is amply borne out in the case of another factory, a fastener manufacturer, that instituted a massive clean up of the facilities and experienced dramatic increase in productivity. Their first time quality measure went up from 82% to 97% in two years. They credit this increase to their efforts to clean up the factory environment. When new management took over two years ago, they found a factory in which cleaning the floor was accomplished by pushing railroad ties along with forklifts to clear gunk from the paths. Now the floor, the walls, and the outsides of the machines are virtually oil-free. Interviewees claimed that the company saw an immediate 10% quality improvement just as a result of cleaning and painting the walls, floor, and machines. They are very strict about safety measures (the only company in which interviewees were compelled to wear hearing protection). A worker politely but firmly chided one of our tour guides when we had passed into a zone which required eye protection and our guide hadn't yet told us to put on our glasses. The company has computerized stations for quality control, testing, and checking during production. Timed screen savers remind workers if it is time to check a sample. Although this company made the initial investment in overhauling their production environment, they do not seem to have implemented an on-going dialogue between environmental management and production management. Evidence for this assertion includes the fact that our interviewee focused on safety and training programs (once he had finished describing the initial clean-up effort); and also that the environmental manager had until recently only been in charge of facilities (grounds keeping and maintenance) and was just beginning to learn about his new area of responsibility. The choice of a non-engineer for this position seems to imply the assumption on the part of management that this position has no need for technical knowledge of the production processes.

Given the experience of this fastener company, it seems likely that the assertion that better housekeeping would improve production quality at the aluminum casting company is one management ought to consider seriously, if they have not already.

### **B. Recycling and Re-use**

#### **a. Recycling and reclaiming of scrap metal and oil/coolants**

The waste material most frequently claimed by companies interviewed was scrap metal (including aluminum flash). 16 (53%) of the sample set of companies listed scrap metal as a

waste product. Of these, 13 (81%) have arrangements in place to sell scrap metal to dealers who recycle or reclaim it. The significant financial motive to recycle scrap metal makes this form of waste reduction almost universal among companies that produce metal waste.

One potentially significant downside to the ease of metal recycling is the possibility that it leads to less effort to reduce raw materials use. In the case of aluminum casting facilities, one interviewee pointed out, high first run reject rates have been the norm in that industry, due to the ease with which companies can "dispense" rejects back into the crucibles to recast them. (This practice of course increases energy use.) The production manager at this plant acknowledged this traditional problem, but told interviewers that first run rejects have been the focus of improvement efforts and have decreased dramatically in the past few years.

A high percent of companies who produce waste oil or coolants also recycle them. 12 companies end up with oils or coolants as a result of their production processes, and 11 of these (92%) have arrangements to recycle them.

#### **b. Exemplary Case of Systematic Recycling Practice**

One company's recycling arrangements stood out as very effective. A manufacturing company has organized the part of the site devoted to disposal and recycling in such a way to maximize recycling activities that bring in income and to minimize disposal costs.

The company has taken steps to re-use (rather than recycle) as many materials as possible. Like many companies, they reuse machine oil by hiring an outside service to pick it up from their holding tank and return it ready to use. For water soluble draw compounds (cutting fluid), they have their own separator so that they process the used fluid on-site. The proportion of waste is therefore very small.

For scrap metals, their recycling program consists of separate dumpsters for every type and quality of metal. The success of their program seems to rest on the investment in one single individual of sole responsibility for sorting scrap into dumpsters. That way they can be sure that, for example, the dumpster of heavy gauge steel does not contain galvanized steel. Before they instituted this arrangement, workers would dump scrap in any available dumpster. This systematic approach ensures the maximum return when they sell scrap metal.

For other materials, they try as much as possible to minimize or eliminate disposal costs. For cardboard, they bought a bailer with which they shrink-wrap cardboard and sell it. For broken pallets, they store them in a dumpster and then, when it is full, pay a lawn care company a small fee to remove them. The lawn care company grinds the pallets for mulch.

In general, this company has found that by instituting a systematic approach to sorting, recycling, and disposing of wastes, they have both increased the amount of income they get from selling off scrap and reduced their disposal costs dramatically. The effort they made to get these results was minimal; merely devoting a significant amount of outdoor space and

acquiring enough dumpsters to sort waste by types. The most important step seems to have been giving one single person the responsibility for overseeing the program.

### **C. End-of-Pipe Treatment**

It is generally considered more environmentally desirable to prevent pollution than to concentrate solely on waste disposal and end-of-pipe treatment. A continuum of desirable environmental practices would start at the highest level with preventing pollution in the first place, then proceed to reusing wastes. Recycling would be ranked lower than reuse, but higher (of course) than disposal. Although this schema is persuasive, it is important to avoid slipping into the habit of condemning companies that have instituted end-of-pipe treatments. First of all, in most cases these are legally mandated, so that effluent waste streams leave the factory with carefully defined "acceptable" low levels of pollutants.

Secondly, and more relevant to this study, in some cases companies have combined waste treatment systems with process input, so that the waste treatment system is also a very important component of the manufacturing process. In these instances, companies have normally combined end-of-pipe treatment with pollution reduction. The best examples are water treatment systems at aluminum casting facilities. One important function of these systems is, of course, to ensure that outgoing water meets the requirements of local sewer authorities. But these systems also provide process water, which in some cases needs to be cleaned when it arrives from the city water authority, even before it can be used in the manufacturing process. These water systems are designed to reuse water many times before disposing of it, so they could as correctly be considered pollution prevention devices as merely waste treatment facilities. One company's water treatment system recycled 97% of the water used; the water which was returned to the river was cleaner than when it was first taken out.

The remainder of this section briefly characterizes the range of end-of-pipe treatments undertaken by companies in the data set. Eleven of 21 companies that practice end-of-pipe treatments have in place water treatment systems. Three of the 11 systems are run with the intent to prevent pollution (in addition to treating water), primarily through reuse of water and separation of reusable and recyclable oils, lubes, and coolants. Two of the systems concentrate zinc to sell it for recycling. Thus, water treatment facilities often combine end-of-pipe treatment with recycling, reuse, or even pollution prevention. More importantly, the success of some of the companies in the data set to achieve multi-purpose "treatment" facilities suggests that this is one area that other companies might profitably investigate.

Seven of the 21 companies have air emissions treatment systems, two to improve interior air quality and five to clean air before releasing it from the factory. Seven companies have in place arrangements for disposal of wastes they cannot, or do not, reuse or recycle.

Five companies expressed interest in learning about alternatives for waste disposal or opportunities for reducing the amount of scrap they paid to landfill. In each of these cases, interviewees described a specific problem and one or several potential solutions of which they

were aware. However, in at least 3 of these 5 cases, the companies were not taking active steps to investigate or research the potential solutions.

For example, several of the companies pay large landfill costs to dispose of rubber scraps. One company had tried selling the scrap, but that customer quickly decided that using raw material was cheaper. Another company mentioned possible alternatives, including burning the scrap for energy or pulverizing it and selling it for use in compounds. But neither of these companies had an on-going research effort to assess alternatives or come up with new ideas. An interviewee from another company expressed interest in drying sludge to reduce the volume of waste they paid to landfill. The company was not engaged in any efforts to determine whether this step would be economically or technically feasible.

In conclusion, even when companies have specifically-targeted potential waste reduction opportunities, they are not always willing to devote resources to research them.



## CHAPTER V. ANALYSIS OF POLLUTION MINIMIZATION PRACTICES

### Introduction

As described above, we observed a variety of waste management practices in this research effort. These observations have aided in the development of a framework which is both descriptive and prescriptive in nature. This framework is explained below along with examples of actual and recommended waste management practices. While we argue that, in general, pollution prevention and waste reduction are desirable goals, we neither advocate nor believe that every firm reach similar levels of low pollution and minimal waste. Rather, based on our interviews and analysis, we conclude that pollution prevention and waste reduction strategies should be tailored to the particular firm to maximize the benefit to both the environment and the firm.

#### A. Outline of the Framework

The parameters used to determine appropriate waste management strategies are two -- the level of environmental risk associated with the pollution type and amount, and the strategic importance of the waste-producing product or process to the focal firm. The combination of the risk level and strategic importance aids in both diagnosing the appropriateness of current actions and in prescribing improvements.

##### 1. Environmental Risk

Risk levels have been recognized quite explicitly by the governing agencies which regulate pollution. Caustic and toxic wastes are clearly at the high end of this spectrum, while wasted production effort is at the extreme low end of this spectrum. A rough test of risk might be an assessment of who could be harmed by the waste stream and how grievous the harm. Clearly toxic waste which contains ingredients which may cause severe environmental damage should be differentiated from wasted motion which will lead only to production inefficiencies, or perhaps to minor injuries to one or a few employees.

That said, risk may be assessed differently in different firms. If a firm's sole production process was word processing, to take a simple example, ergonomic problems or wasted motion might cause repetitive motion injuries to a large group of workers. In such a situation, while still not comparable to the risk presented by toxic waste streams, the risk associated with wasted motion would be more than trivial. Thus, individual firms need to do an assessment of environmental impact on each of their products and processes. There is no "one size fits all" solution.

High risk products and processes should at minimum be in compliance with regulatory restrictions and policies, and should also receive significant managerial attention. Not only environmental managers, but production managers and other employees should be aware of the ramifications of the use and production (i.e. in terms of byproducts of a given production

process) of material with high environmental risk. The pollution minimization mechanism used should be consistent with the level of liability to which the firm is exposed.

We reviewed our interview data and the products and processes in use at each firm to analyze each company's pollution minimization mechanisms and amount of environmental liability. For the three strategies defined in the previous chapter (namely, pollution prevention; recycling and reuse; and end-of-pipe treatment), each group has approximately the same number of firms whose environmental liability is small (7, 7, and 5 respectively of 14 companies with small liability). Of the 8 companies with high liability, however, all practice end-of-the-pipe treatment, while only two recycle or reuse and two practice pollution prevention. This suggests that companies with high liability are most directly preoccupied with compliance and with making sure that their effluent waste streams meet environmental regulations. Examination of the companies with a medium amount of liability seems to support this trend. Of the 8 companies with medium liability, all 8 practice end-of-pipe treatment, 5 recycle or reuse, and only 1 engages in pollution prevention activities.

Remember from the previous chapter that many of the companies engaged in pollution prevention appear to be motivated by economic considerations, especially by the goal of reducing materials costs. This study concludes that companies with high liability, faced with the immediate concerns of meeting environmental regulations, are less likely to engage in comprehensive pollution reduction programs and more likely to concentrate on waste treatment facilities. On the other hand, companies with low environmental liability are more free to devote attention and resources to projects that reduce raw material use or involve the introduction of new machinery and processes. The waste reduction efforts of this group of companies are mostly economically-driven, although they have the effect of reducing pollution as well.

## 2. Strategic Importance

There is another important dimension to the assessment of waste reduction or pollution prevention strategies. We have called this dimension "strategic importance." While risk is a function of potential harm to people and the environment, strategic importance measures the potential of a product or process to help (or hinder) the firm's competitive position.

The level of **strategic importance** is associated with the firm's source of value creation. By this we mean the **extent** to which a certain process or product is integral to the means by which the firm generates profits. In manufacturing firms, processes in support functions, such as cleaning the plant or the machinery, may generate pollution. However, such processes are often separable from the firm's core processes, so that if competent suppliers are available (see chapter VII below) the process can be outsourced without affecting the attractiveness of the firm's key sales offerings. Thus, their strategic importance is low. In contrast, in a firm which sells their services as a cleaning company, the waste generated from cleaning processes is the firm's largest cost factor, and is of critical importance in determining the quality (i.e. speed,

cleanliness, etc. ) of their product offering. Thus, the cleaning process is of high strategic importance to this firm.

Every firm must thus assess the strategic importance of its various functions in a manner consistent with its own strategy, social responsibility, and competitive realities. For example, automotive manufacturers in the United States did not recognize the potential strategic importance of waste in the form of inventories. Eliminating waste in this area (via JIT inventory practices, for example) has enabled significant efficiency improvements.

Of the firms in our sample, the majority (17 of 30) had environmental liability which we categorized as of moderate to high strategic importance. Nine were categorized as having waste productivity products and processes of high strategic importance, and nine more were of moderate to high strategic importance.

The actual strategies each of the focal firms enacted are described below. Since all firms in our sample do not follow the same prescriptions, no clear relationship is immediately apparent between the level of strategic importance of the products or processes that produce waste and the firm's waste reduction or pollution prevention strategies. However, we use the combination of environmental risk and strategic importance as a powerful framework not only to organize the firms into descriptive categories, but also to generate general rules of thumb for recommended actions.

Assessing both the level of risk and the level of strategic importance is an important component of developing appropriate strategies for coping with waste. This does not preclude the important step of identifying sources of waste. Many firms were poorly equipped to even identify these sources, much less to categorize them according to specific criteria. Still, such a systematic approach is vital to ensure an optimal fit between a specific problem and its solution (or range of possible solutions). CAMP may provide services at both the identification and classification level for a broad array of firms.

## **B. Laying out the Framework**

Combining environmental risk and strategic importance yields four possible situations: Low environmental risk, low strategic importance, low risk, high strategic importance, high environmental risk, low strategic importance and high risk, high strategic importance. Given these two axes, four distinct quadrants can be used to define all firms. Different products or processes for the same firm can fall in different quadrants, of course. However, as discussed below, we have generalized our results so that each firm is shown in only one location on the grid.

It may be confusing to observe *firms* categorized under the headings "High (or low) Strategic Importance." Presumably, firms with low strategic importance are not viable entities, and are also likely to be poor candidates for a study of best practices in business. It is therefore

important to point out that our study is not concerned with the entire firm, but only with key automotive processes undertaken by the plant we visited.

The strategic importance - or impact on profits- of these processes in some cases was not of great consequence to the firms in question. Some of these firms supply materials to automotive suppliers based on historic relationships or on the expectation of future business, rather than because the products are profitable by themselves. The plant we visited may also be small and its automotive business relatively unimportant to the firm as a whole. Due to this study design, there is no clear correlation between the profitability of a given firm and the strategic importance of the automotive related product or process which was chosen as the subject of our inquiry. A highly profitable firm may serve automotive customers by providing products and processes which are of low strategic importance in the sense that these products or processes do not significantly affect the competitiveness of the overall firm.

If a firm's core business is plating for automotive customers, and this is the process which was the focus of our interview and plant tour, the strategic importance of the plating process to this firm would be categorized as "high." This is because changes in the efficiency of their plating process would have significant impact on the competitiveness of the firm overall (i.e. on their ability to price their core services competitively). If plating for automotive customers was a minor line of business for another firm in our sample, and the bulk of their business efforts were in other areas, changes in the efficiency of their plating process would not have significant impact on the firm's overall competitiveness. For this second firm, the strategic importance of their plating process would be categorized as "low".

Regardless of a given firm's orientation towards environmental sustainability, they must attend to their economic goals and obligations. Thus the strategic, or competitive, sustainability of their operations is important, whether or not they explicitly recognize the equally important elements of exemplary environmental performance.

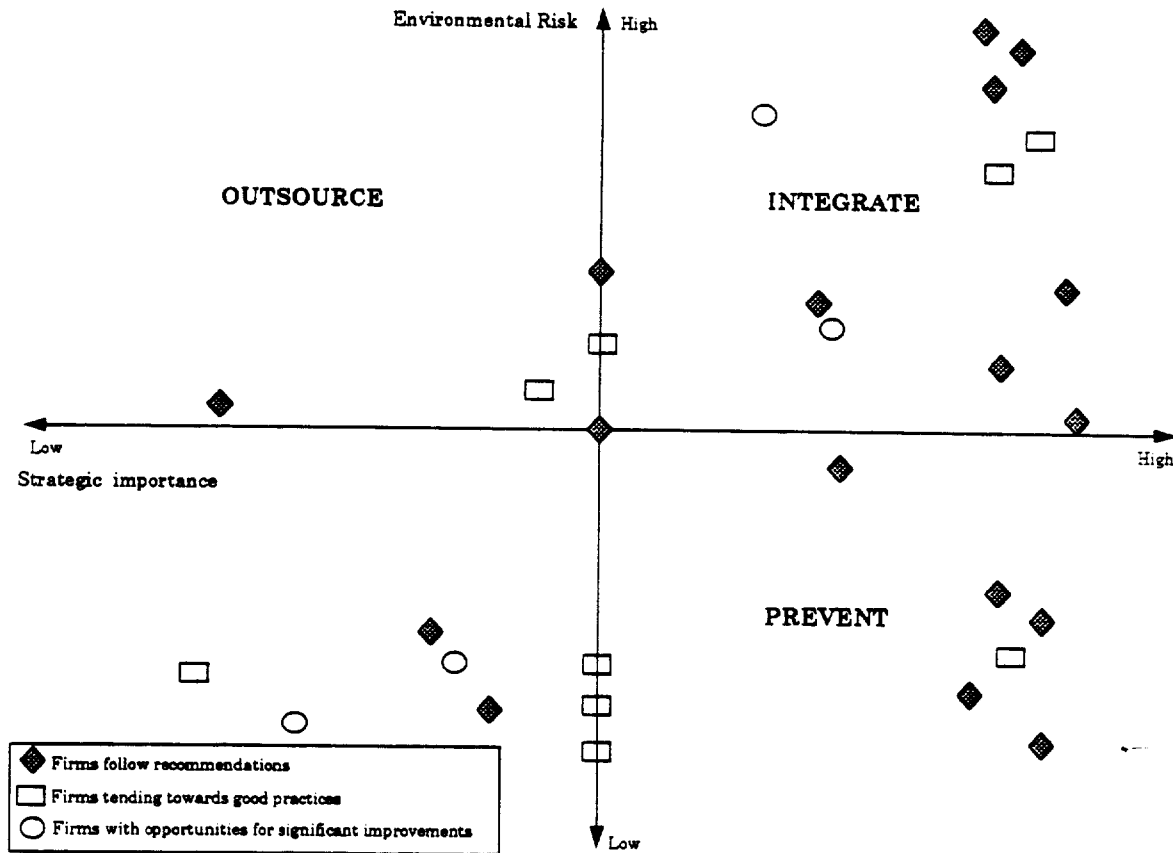
The framework developed and tested in this study uses common terms in specific applications, as is common practice in applied research. In particular, "Prevention" refers to a set of proactive behaviors, rather than the simple act of avoiding pollution. Avoiding pollution includes a number of efforts, mainly small and dis-integrated, which serve to prevent pollution or to limit the emissions or waste associated with a given process or product. In this sense, prevention is a sensible, low cost, effort which should be undertaken continuously. We advocate that waste reduction or elimination - or this generic type of prevention - be accepted as good business practice by all firms. However, in our more formal framework, prevention takes on a markedly different connotation. Prevention, as a waste reduction strategy at the firm level involves a much more high level, tightly integrated effort to not simply react to opportunities which become apparent, but to seek out specific ways to prevent the creation of (present and future) streams of waste.

At this level, major capital projects, relationship or organizational restructuring, and/or re-assessing lines of business may be necessary. Prevention in this sense is a top management concern and as such we differentiate a firm-wide prevention focus from the everyday efforts of firms to refrain from or minimize creation of waste.

A major Northeastern Ohio automotive supplier demonstrated a well-executed "Integrated" pollution prevention strategy. The extent of the "Prevention" practices which are part of this strategy is best exemplified by the firm's decision to make a large capital investment to reduce its hazardous waste. Prior to 1989, this firm treated ash on-site and disposed of the hazardous waste and sludge which resulted. The environmental liability associated with the pickling process which produces the ash was moderate and its strategic importance to the firm was high.

An Ash Recovery System which came on stream in 1989 recovers sulphur which is reused in this firm's pickling processes, and generates ferrous sulphite and sludge waste. The ferrous sulphite is converted to hepta hydrate crystal which is a salable material used in fertilizers and magnetic tape. The result was the creation of useful byproducts from this process a 70% reduction in hazardous waste. has been reduced by 70%, this system could not be justified using traditional cost/benefit financial analysis. (In contrast to many pollution prevention activities, the \$10 million investment in this case could not have been justified on economic criteria alone. It was approved at the highest levels of the firm based on a strong corporate policy which supported pollution prevention, and which took into account the impact of the investment on the surrounding community as well as on the firm.

**Exhibit 4.1: A Framework for Pollution Minimization**



**a. Quadrant One: Low Risk, Low Strategic Importance**

Firms with environmental low risk, low strategic importance face a situation which demands little, if any managerial action. Neither worker health, environmental health, nor fiscal health of the firm are **threatened** and, unless there is some change in the processes or products which becomes a **threat**, the firm needs no overt strategy for addressing environmental issues. The only action which might be prudent is to understand how/why the level of risk is low and to guard against any action that would elevate this risk level. For example, one firm buys its rubber and generates little scrap, so its current liability is low. However, before any new process is introduced, it should be evaluated for its impact on the plant's potential waste generation. Not only traditional cost/benefit analysis, but also environmental impact analysis must be performed.

**b. Quadrant Two: High Risk, Low Strategic Importance**

High risk, low strategic importance situations are often well suited to outsourcing to firms with unique ability to manage the pollution problems inherent in the process.

For example, automotive assemblers and first-tier suppliers have moved to outsource processes such as surface finishing and heat treating. The results of the present study indicate that outsourcing is a common feature throughout the northeast Ohio auto supply chain. It is not, however, a pervasive feature, as there are examples of companies that have elected to bring processes in-house at the same time that other companies are choosing to outsource the same processes.

*Outsourcing to Mitigate Environmental Risk.* The set of 30 companies interviewed contains 6 companies to which other firms outsource processes that have the potential to create a high environmental liability.<sup>11</sup> These firms are termed “outsourtees” within this report. One of the six makes a product that replaced a polluting product, but the rest supply finishing or waste disposal services, primarily to companies wishing to rid themselves of the environmental burdens associated with these activities.<sup>12</sup>

Ten companies in the dataset (30%) outsource processes. The largest number of these (5) outsource plating. Two outsource heat treating. One outsources a part of the production process, while two are assemblers, so they outsource the production of all the components used to make the final product.

By far the largest percent of the dataset that outsources hires other companies to handle their wastes, both hazardous and non-hazardous. Thirteen companies (46%) outsource disposal, while nine companies (32%) pay for removal and recycling or reclaiming of material. The smallest number of firms (3, or 11%) mentioned hiring a consultant to set up systems to bring plants into environmental compliance. One company, for example, hired a consultant with expertise in EPA air emissions to set up an air treatment system. On the other hand, a number of companies, instead of hiring outside consultants, were willing to invest in employee time to select and install water treatment systems.

Outsourcing appeals especially to plant managers who wish to avoid or shed responsibility for the costs and expertise required to conduct certain processes and services in-house. For example, one company, which is already engaged in a major site clean-up (in which the environmental damage was caused by on-site waste disposal by the previous company in that location), elected to outsource plating because of the expense of waste disposal. Another company frankly explained its decision to outsource plating and coating as “mainly to avoid

---

<sup>11</sup> We did not include in this category production of raw materials (a group which would have included all of the firm in the sample except one firm which specialized in making raw materials (steel). We also did not investigate the question of equipment outsourcing.

<sup>12</sup> Of note, the study pursued interviews at these companies in order to complete supply chains. Only two of the six outsourtees interviewed were listed on the Elm list. The remainder of their names were supplied by companies during interviews.

dealing with the environmental issues involved.” Thus, these companies in quadrant 2 have reduced their high potential environmental liability to a low or moderate level by outsourcing dirty or dangerous processes to specialists. This can be a wise choice if the strategic importance of the related product or process is relatively low and losing control of it will not seriously jeopardize the firm’s business prospects. However, it is often beneficial to maintain close communication links with the outsourcees; three of those we interviewed gave examples of how they had advised their customers how to reduce emissions at both their own and the outsourcees’ facilities through improved product and process design. However, none of the three gave this advice on a systematic basis. (One of them, a waste management supplier, was thinking about setting up a consulting practice to provide this service.)

However, examples also exist of companies bucking the general trend by electing to bring processes in-house. Two companies do finishing or heat treating in-house. One company does its own heat treating because of a company preference for keeping as many processes as possible in-house. The other company, however, brought coating in-house to address the problem of a 10% reject rate at their coating vendor. The company bought the assets of a small coating line and achieved a reduced reject rate of 1% once it was running in-house. The company treats the coating line as an outside process for business purposes. It also sometimes supplies finishing to other companies when there is excess capacity (although this service is not advertised). One company had a less successful experience with in-house plating; our interviewee complained about excess capacity.

### **c. Quadrant Three: Low Risk, High Strategic Importance**

In a low risk, high strategic importance situation, a strategy which focuses on prevention is optimal. Due to the high strategic importance of the process or product in question, reducing the waste, or preventing the pollution has the best opportunity for maximizing the firm's competitive success. If a firm outsources a process with high strategic importance, they risk losing their distinctive competence in this area, either through competitor actions which imitate (or effectively “steal”) their process, or through quality problems which have their roots in the outsourcing firms.

Working with customers and suppliers on prevention efforts gives the focal firm even more leverage than working alone on prevention tactics. Suppliers and customers are both potential sources of new ideas and approaches, and allies in the effort to act on prevention strategies which are initiated by the focal firm. This study found a variety of evidence that good customer supplier relationships aid prevention efforts. However, this potential is scarcely tapped in the Northeast Ohio automotive supply chain.

*Prevention Using Customer Supplier Relationships.* The study considered the question: do customer-supplier relationships exist that address waste reduction? In 19 of 30 cases (63%), companies gave at least one example of working closely with either a customer or supplier. Ten of these have relationships used to tackle issues of quality, delivery, and/or design. Nine (30%) gave examples of using those relationships to address environmental issues. Examples



are given below to illustrate the experience of companies in the data set. Of the remaining companies in the study, 9 do not have such discussions, and 2 did not provide enough information to characterize such a relationship.<sup>13</sup>

Communication between suppliers and customers is particularly beneficial in increasing the success of pollution prevention efforts. There is a high potential for firms to build on existing relationships with customers, to extend their conversations about cost-reducing design changes to encompass cost-reduction by reducing generation of pollution.

Of the eight companies whose customer-supplier relationships address waste reduction or environmental issues, three are companies that specialize in dealing with environmental problems, that is, plating and hazardous waste disposal companies. Of these three, one gave an example of a customer (Honda) helping to determine the source of an unspecified problem. Another one offers materials substitution advice as an informal but regular part of their service. The third described the close relationships with area aluminum casting companies that allowed him to develop a patented lubricant which he now markets world wide. These customers and potential customers allowed him to test the product in the development stages. He characterized big companies as more helpful during the experiment stage, but small ones as less lethargic about adopting new technical ideas and products. Although this interviewee would not discuss his suppliers, he did credit them with providing a significant amount of technical assistance.

The remaining five companies gave the following examples of customer or supplier involvement in waste reduction or pollution prevention:

- One worked with its parent company/supplier to change the dimensions of the raw material they received. This allowed them to produce their product with less wasted raw material.
- One worked with customers to design machines whose performance criteria include pollution prevention. For example, they built molding systems that yielded a clean surface on the finished part. But this company also pointed out that customers do not always appreciate machines designed with waste reduction in mind. Instead of using a lost foam casting machine (foam is burned away by hot metal, leaving a clean cast and no residue), one customer changed to outsourcing the process.
- One manufacturing firm suggested that their customer review salt spray resistance specifications, which they felt were unnecessarily high for an interior part. The customer, realizing that this specification had carried over from a previous design, decided to make the recommended change. The result was a finish that the supplier firm could do in-house, which not only prevented the use of environmentally-damaging finishing, but also saved time and transportation.
- One company, which claimed much benefit from technical advice and assistance from suppliers, gave one concrete example. Their machined shafts were experiencing high reject rates both in-house and at the customer. They worked with their supplier of forged

---

<sup>13</sup> It was not always harder to communicate across firm boundaries within them. We visited two plants owned by the same company which used the same process, yet had very different approaches to water treatment. Each plant was convinced its approach was superior.

shafts to get slightly larger ones, which resulted in much lower reject rates. Even though more material went into the forged shafts, the savings across the board (rejects, time, etc.) made this choice worthwhile. This company also mentioned their willingness to experiment with lubricants and coolants according to their supplier's recommendations.

- One company, a metal finisher, worked with a supplier ("pushed them") to develop a paint which contains no hazardous materials. The same company also described a relationship with a supplier of coatings and cleaning chemicals in which the supplier sells coalescers that prolong the life of cleaners by skimming oil off the top of the cleaning bath. The company we interviewed said that the coalescer paid for itself in reduced chemical costs in six months; the supplier made up for selling a smaller quantity of chemicals by selling more coalescers.

In general, it seems as though companies engaged in pollution prevention activities have close customer-supplier relationships. All but one of the eleven companies that practice pollution prevention show evidence of such relationships for addressing issues of quality, delivery, design, etc. Half of them (6, or 55%) use that relationship to address environmental and waste reduction issues. By contrast, among the group of companies that engage in reuse and recycling, only 4 of 13 (31%) have customer-supplier relationships that address waste reduction. And, among the 21 companies with end-of-pipe treatment systems, 6 (or 29%) have such relationships. All but two of these companies is an "outsourcer," that is, a company to which other companies outsource either processes such as finishing and heat treating or disposal. It seems, therefore, that companies that supply finishing or disposal services benefit from maintaining healthy customer-supplier relationships. Of the three companies for which not enough is known to determine what pollution and waste strategies they practice, only one has customer-supplier relations that address waste reduction issues. Unlike other companies in the dataset, however, the result is not the reduction of waste in the manufacture of a product itself. Instead, this company works with customers to design and construct machine tools that create less waste.

Of note: although this study finds that companies engaged in pollution prevention enjoy close customer-supplier relationships, the evidence in some cases consists of a single example. Thus, although the potential structure is in place to utilize close customer-supplier relationships to effect pollution prevention, we did not find any examples in which reduction of waste (either due to pollution or due to inefficient production effort) was discussed consciously and regularly. Instead, most companies express concerns about maintaining quality or keeping proprietary information safeguarded. They cited these concerns as reasons for not developing the kind of customer-supplier relationships that could address pollution prevention at the level of materials substitution, decrease of raw materials used, or change to the production process.

#### **d. Quadrant Four: High Risk, High Strategic Importance**

Situations in which both environmental risk and strategic importance are high demand the most managerial attention. Often issues in this area are already focal, due to regulatory pressures or competitive pressures. It is at high levels of both risk and strategic importance

that managers must integrate their firm strategies and their waste management strategies, to develop rich and interdependent coping mechanisms which will manage both the potential costs and liabilities and the potential benefits and opportunities inherent in this situation.

To best manage this situation, environmental managers should be directly involved with managerial decisions, including production and design decisions. At the same time, production and design personnel need to be aware of key pollution issues and ramifications of waste (both strategic and environmental). The firm must invest in appropriate training to achieve this goal, and may need to make other significant investments in understanding and integrating the pollution minimization processes, waste reduction processes, and revenue producing processes of the firm.

In this quadrant, it is tempting for managers to pursue either prevention or outsourcing (each of which is an appropriate approach for another quadrant, as discussed above). High risk pushes firms to try to outsource the offending process to another firm. High strategic importance, particularly on the cost side, encourages firms to try to prevent the offending waste or pollution source from existing or growing. When both of these elements are high, however, neither prevention nor outsourcing by itself is sufficient. Instead, these firms should adopt a fully integrated approach which combines both prevention and outsourcing, but maintains a focus on the inter-relatedness of these strategies. Outsourcing, for example, should be closely coordinated by firm personnel, who will keep control of the processes that are outsourced through a collaborative relationship with the outsourcer. Such a partnership reduces environmental risk while also reducing the loss of competitive advantage due to loss of control of the outsourced process. Similarly, prevention efforts should be enhanced by collaboration with customers and suppliers as discussed in the strategy for Quadrant 3 (above).

An integrated approach to waste management does not consist only of prevention and outsourcing tactics. A more complete list of important elements of a fully integrated waste management program includes cooperative prevention efforts, collaborative outsourcing arrangements, a systematic approach to waste management, linking environmental and production management, and decentralizing environmental responsibility throughout the firm.

Prevention and outsourcing efforts have been discussed at length elsewhere in this report. We will now discuss each of the remaining elements in turn, examining the degree to which our sample fulfills the criteria for a systematic approach to waste management, linking environmental and production management, and decentralizing environmental responsibility throughout the firm. It is important to note that while no single firm incorporates all these elements, examples of each were found and efforts are underway in other firms which demonstrate a trend towards more integrated waste management efforts. A proactive approach to environmental management similar to this integrated program has been associated

with above average bottom-line success in the (non-automotive) firms studied by Dechant and Altman.<sup>14</sup>

*Systematic Approach.* For the purposes of measuring approximate degree of systematic approach to pollution minimization, the following assumptions have been made. First, the existence of an environmental manager signifies a systematic approach, compared to those companies that relegate decisions involving environmental issues to non-specialists within the company. Second, the characteristic of having or working towards QS9000 likewise suggests a more systematic approach than not doing so. Third, awareness of ISO14000 indicates that a company makes an effort to keep apprised of future environmental standards.

The following chart grades companies in the data set into the categories of most systematic, moderately systematic, least systematic, and not systematic. The method of determining the category was to assign one point for the presence of each of the characteristics listed above (existence of environmental manager; working towards of having QS9000; and awareness of ISO14000).

	Most Systematic	Moderately Systematic	Least Systematic	Not Systematic
# of companies	4	9	12	3
Percents	14%	32%	43%	11%

A comparison of the degree of systematic approach with company strategy towards environmental issues (the above-described groupings of companies that engage in pollution prevention; those that practice recycling and reuse; and those that rely on end-of-pipe treatment) does not yield any strong relationship between these two variables. One might assume that companies with a more systematic approach to environmental management would be more likely to practice pollution prevention, while those with the least systematic approach would be more likely to practice end-of-pipe treatment. Instead, "most systematic" companies practiced recycling/reuse and end-of-pipe treatment slightly more frequently than prevention. The majority of companies in the "least systematic" category practiced end-of-pipe treatment (8 of the 12, or two-thirds). This is more than the number of "least systematic" companies that practice pollution prevention (less than half do, that is, 5 of 12). However, 55% of the companies that practice pollution prevention fit into the "least systematic" category, while only 40% of those in the end-of-pipe group were "least systematic".

One possible explanation for the absence of the expected relationship between these two variables was suggested earlier. Some of the companies in the pollution prevention group gave only one or a few examples that demonstrated prevention. The result described here

<sup>14</sup> See: "Environmental leadership: From compliance to competitive advantage," Kathleen Dechant and Barbara Altman, *Academy of Management Executive*, 1994, Vol 8 No. 3, pp 7 - 27.)

makes sense if prevention is not part of a systematic effort to address environmental issues and integrate them into process engineering and management.

In addition to examining the systematic approach to environmental management, we examine the efficacy of formal environmental positions. If the environmental manager is the locus of decision making, more consistent decisions regarding environmental policy will result. As might be anticipated, a relationship exists between high environmental liability and likelihood that a company has a formal environmental position. The details follow in chart form.

First, this chart divides the data set into companies that do not have an environmental position, those that do have a formal position, those in which environmental decisions are the responsibility of someone at headquarters, and those for which there is no data.

	No	Yes	At HQ	Don't Know
Totals	11	12	3	4
Percents	37%	40%	10%	13%

For companies that do not have a formal position, decisions about environmental and waste issues are made by the owner, vice-president, each department, the quality control department, and the engineers (one case each) or by the plant manager (two cases). For companies with a formal position, in two cases, a separate department or position exists devoted exclusively to environmental responsibilities; in four cases, Environment, Health, and Safety (EHS) is one position; and in two cases, EHS is part of a position.

- Of the 13 companies with low liability, only 3 have a designated environmental position, while 9 do not. For one, there is no information.
- Of the 8 companies with medium liability, 5 have formal positions, while only 1 does not. For 1 of these companies, environmental policies are handled through headquarters. There is no information for the remaining company.
- Of the 7 companies with high liability (those which handle hazardous materials), 3 have formal positions and 2 handle environmental policies through headquarters. 1 has no formal position and there is no information for the remaining company.

Some kinds of waste reduction practices relate positively or negatively to existence of a formal environmental position within a company. For many types of waste reduction, the number of companies that have formal environmental positions approximately equals the number who do not. (Instances in which no data was acquired on this subject are excluded from this list.)

For the following five types of pollution minimization practices, the correlation is weak at best:

- selling scrap metals (5 have a formal position; 6 do not; 2 do at headquarters).
- recycling or reclaiming wastes, (5 have a position; 4 do not; 1 does at HQ).
- having air emissions treatment facilities (1 has a position; 1 does not; 2 do at HQ).
- having recently switched to an aqueous system (2 have a position; 1 does not).

- using returnable packaging (2 have a position; 2 do not; 1 does at HQ).

For a few types of waste reduction, the presence or absence of a formal environmental position made a greater difference.

- Of those that redesign process to reduce waste, none of the four have an environmental position.
- Of those that have on-site water treatment, most (3) have formal environmental positions, while only 1 does not and one does at headquarters.
- Of the 5 companies that expressed curiosity about a specific waste reduction opportunity or said they were actively investigating one, only 1 company has a formal environmental position.

It seemed at first surprising that companies which regularly redesign process to reduce waste do not have formal environmental positions. Companies engaged in routine redesign are attempting to reduce raw materials consumption, motivated by the desire to lower their production costs as well as costs of landfill disposal. Although several of these companies provided excellent examples of successful waste reduction activities, these reductions require the efforts of design engineers and production managers. A person whose job responsibilities encompassed the traditional universe of "environment, safety and health" would not normally be a part of such a project. Therefore, there should be no reason to expect that companies who redesign the product to reduce waste would have formal environmental positions.

Most of the companies that are curious about possible avenues for waste reduction do not have formal environmental positions. Perhaps this explains why 3 out of 5 of them are not currently taking any active steps to investigate the waste reduction possibilities they mentioned during interviews.

*Linking Environmental and Production Management.* Linking environmental and production management is another element of a fully integrated waste management program. Although a large dichotomy exists in many companies between environmental management and production management, a few examples suggest that the potential exists for cooperation between these two functions. Two examples are given here of aluminum casting facilities. Both have sophisticated waste water treatment systems that not only treat outgoing water but also treat water that is used in production processes. Therefore, the water treatment systems function both as waste management tools and as a resource for production.

In both plants, one person has responsibility for EHS matters. Both of these people have experience as production engineers or managers in other industries. Unlike some environmental managers (such as one in a fastener-producing company who was promoted from a position managing grounds keeping), both of these people understand the production process and have the experience that would be required to integrate waste reduction efforts and production improvement.

One interviewee in particular was vocal in his criticism of management for not taking advantage of the potential for using the waste water treatment system to track and improve quality. He pointed out that information on the amount and type of waste generated was informative about the production process, especially quality problems. For example, when dies are wearing out, they produce more waste fluid and more flash. Thus, when a monitor shows a spike in the use of a specific fluid, it usually means that there is a problem with a machine. This interviewee advocated implementing a systematic coupling between waste management and quality control, but, at the moment, management is not doing anything to accomplish this.

Although this interviewee criticizes management for not taking full advantage of the potential he sees for linking waste management and production control, this company and another aluminum casting company understand the necessity of devoting the time and expertise of a dedicated engineer in order to develop a functioning waste water treatment system. One interviewee stated that his system "had more bugs than a candy shop in Florida." He has had to tinker with the system to adapt it for use in his plant. By contrast, other companies expect to implement "off the shelf" waste treatment systems without this level of technological and institutional support.

One company that had a disappointing experience with an "off the shelf" pollution prevention technology also provides valuable insight into the role of environmental manager. This company supplies injection molding, sealing and coatings of nylon, rubber, and other materials. Cleaning parts before coating is an important step in their operation. The environmental manager played a major role in the recent (within the past few years) purchase and installation of an aqueous degreaser intended to clean parts destined for a paint-style coating line. This manager has a management/business undergraduate degree and experience as a "Jack of all trades manager." In his current position, though, he appears officially unconnected to the manufacturing processes at the plant, although he evinced a familiarity with some plant operations during the tour. His official responsibilities include handling certification and dealing with wastes and emissions, along with managing employee safety training. This environmental manager and the plant's "environmental supervisor" (who was promoted from the rank of operator, without much training) prefaced their remarks about the aqueous degreaser with the admission that "the salesman had done a really good job." In other words, the machine was oversold; it never did what the firm needed it to do.

Some of the reasons for the machine's failure seem rooted in the disjunction between production management and environmental management. For example, one immediate problem was that the installation of the aqueous degreaser coincided with an increase in volume of parts handled by the coating line. It is possible, though not certain, that a closer working relationship between the production and environmental sides might have alerted the environmental manager to the projected expansion, causing him to look for a larger aqueous cleaning machine. Another problem that arises from use of the aqueous degreaser derives from scheduling. The company interrupts scheduling fairly frequently due to rush orders (a company specialty). Since they prefer to degrease parts ahead of time, they encounter the problem of rust on parts degreased. While this is not an intrinsic problem with the aqueous

machine, it is a problem of integrating the characteristics of an aqueous system into the company's production process.

The environmental manager himself explained the source of the problem in precisely these terms: "when I got involved in the aqueous cleaner, that actually involved process engineering." But his training did not cover process or design engineering, nor did he have avenues for seeking the help of engineers within the company. His lack of technical training translated into the naive assumption that such a "plug-in" machine would meld unproblematically into the company's production process. Instead, in addition to the above examples, unforeseen problems arose, such as the need to handle a new kind of waste, the sludge produced by the aqueous degreaser. The solution to this problem entailed the additional expense of an evaporator purchased to reduce the sludge to a solid.

Unlike in the above example, some companies have environmental managers with previous production engineering and management experience. However, that does not automatically translate into effective cooperation between waste management and production management. One example indicates that, in general, EHS issues are not considered a priority to management. One interviewee said that when workers complain that the position of their machines makes them move or bend unnecessarily, he passes the information on to management but is discouraged by how long responses take. If the request or problem is small or easily fixable, he simply asks the hourly worker assigned to help him to make the requested change. By avoiding formal channels changes can be made more quickly, but the disadvantage is that all change is piecemeal and not at all systematic.

Although this example relates to health and safety, it suggests the extent to which the responsibilities of EHS managers can be pushed to the sidelines. In companies dedicated to building effective EHS programs, these managers are given plenty of resources to develop training programs and institute safety measures. However, even when these managers have previous experience that enables them to understand the production processes for which they are developing waste management systems, they are normally kept from "interfering" with production processes.

*Distributing Environmental Responsibility.* A potential solution to the problem of separated environmental and production is to decentralize authority for the environment throughout the firm. While the potential advantages of decentralized environmental responsibility are significant, there are also serious drawbacks. Without a specialty staff promoting environmental agendas, these can easily get lost in the press of other work. Environmental considerations can be relegated to the status of secondary concerns, to be addressed only after the more primary production process work.

Some auto assemblers have begun to adopt a decentralized approach to environmental management. At Saturn, for example, environmental responsibility was designed to sit low in the organization. Employees were made aware from the start, through specialized training and time devoted during team meetings, that environmental issues were a priority to the



company. Sandra Rothenberg<sup>15</sup> has found that, in the early years, Saturn's environmental group succeeded in integrating waste reduction into the company's production activities. When, however, GM informed Saturn's top executives that the company had to begin making money, the shift to cost reduction as the primary focus had a detrimental effect on environmental achievements. Because environmental performance was not reported directly to teams along with cost, quality and productivity, it ceased to be addressed by team members. Only environmental staff remained attentive to waste reduction issues, and even they were driven to find and implement reductions on the basis of cost reduction. This preoccupation with cost reduction discouraged environmental investments that had longer term, or no, payoffs.

While some large companies like Saturn seems to be adopting the principals of decentralized environmental management, this study identifies no such trend for smaller and lower tier suppliers. Rothenberg's study suggests that decentralization is not necessarily the solution to the extreme disjunction between environmental management and production management. Yet, distributing environmental responsibility appropriately --- rather than concentrating all decisions in one central location or else diffusing responsibility so extensively that it becomes no one's concern -- is the major challenge facing those northeast Ohio automotive suppliers that are seeking excellence in waste management and pollution prevention.

### **Section Summary**

Thus our framework provides a diagnostic approach which can be useful in identifying and explaining potential improvements from pollution minimization to individual firms, a supply chain, and the Northeast Ohio region as a whole. Below, we summarize the actual vs. prescribed waste management efforts by quadrant.

#### **Quadrant 1**

In quadrant 1, firms with low environmental risk and low strategic importance have little compelling need to pursue prevention, outsourcing or integrated waste reduction strategies. Of the six firms in this quadrant, two were engaged in multiple waste management efforts, while the other 3 were involved in no pollution prevention efforts and some limited degree of outsourcing. One firm entered this quadrant by virtue of their outsourcing efforts, but remained on the border between quadrant 2 and quadrant 1.

#### **Quadrant 2**

There are no firms in our sample with high environmental liability and low strategic importance. Firms who might otherwise be in this quadrant were found to have reduced their environmental liability by outsourcing hazardous or pollution-prone processes

#### **Quadrant 3**

---

<sup>15</sup> Sandra L. Rothenberg, "Environmental Management: Struggling in the Battle for Attention," Academy of Management: Transforming Work and Organizations for the 21st Century, Vancouver, B.C., Canada, August 6, 1993.

A least nine firms demonstrated low environmental risk and high strategic importance. We advocate that these firms focus on pollution and waste prevention. Indeed, five of these nine firms were engaged in at least one prevention strategy. Three who did not use prevention strategies were on the border between quadrant 3 and quadrant 1 and one firm was on the border between quadrant 3 and quadrant 4.

#### Quadrant 4

Members of this quadrant, with both high environmental liability and high strategic importance numbered 13. Three of these were on the border of all four quadrants and pursued outsourcing strategies.

Of the thirteen firms, eight had two or more waste management efforts underway. Four pursued a single waste reduction or pollution prevention strategy or technique and one firm apparently had no such efforts

Thus, in the four quadrants there was substantial evidence of firms adhering to the general recommendations of our model. However there were substantial opportunities for improvement in waste management practices.

CAMP, and organizations like CAMP, can provide many important and valuable services to firms. First, they can identify sources and types of pollution or waste and measure the levels of the problems. Second, they can measure the levels and amounts of both environmental risk and strategic importance of these products and processes with respect to the focal firm. Third, they can aid in determining and implementing appropriate strategies for the firm using the framework developed here. CAMP would be most likely to gain early victories by approaching firms where low environmental risk and high strategic importance are associated with their waste producing products and processes. It is in these situations that prevention tactics and efficiency improvements stand to result in significant tangible impact, which will pave the way for future efforts in less obvious applications of exemplary waste management practices.

**CHAPTER VI**  
**PRODUCTION PRACTICES IN NORTHEAST OHIO:**  
**LEAN PRODUCTION AND ITS WASTE REDUCTION POTENTIAL**

**A. State of the Northeast Ohio Auto Supply Industry Relative to the United States and Canada**

**Introduction**

As mentioned in the introduction to this report, lean production emphasizes reducing each of Ohno's seven types of waste by reducing inventory to a minimum and by working continuously to improve the production process. Lean production can lead to dramatic performance improvements; a 1990 study of automotive assemblers found that lean producers used 1/3 the space and 1/2 the labor hours to produce products with 1/2 the defects of plants using traditional mass production methods.<sup>1</sup> Lean production requires far-reaching organizational and technological changes. Within a firm's own manufacturing operation, it involves reducing buffers through Just-in-Time inventory systems, producing only what is needed by downstream "customers," whether internal or external; pushing down responsibilities for quality inspection and the specification of work tasks to motivated, multiskilled workers organized into teams; eliciting a steady stream of ideas for process improvement (kaizen) from employees at all levels. Added to this, customers are likely to demand that suppliers assume substantial responsibility during product development; accommodate customer requests for engineering changes in their product or manufacturing process; become highly reliable with respect to quality and delivery; and have the ability to respond quickly in case of problems.

Lean production is significantly correlated with increased employment and sales, according to research by Daniel D. Luria of the Industrial Technology Institute in Ann Arbor.<sup>1</sup> However, firm profitability is more correlated with what he calls 'distinctiveness'--the ability of a firm to distinguish itself from others, via a unique product or process. (Truly complete adoption of lean practices could be a source of distinctiveness, because it is so difficult to do.) In this section of the report, we will examine production practices in the Northeast Ohio auto supply

---

<sup>16</sup> For more on lean production see Womack, J., D. T. Jones, and D. Roos (1990), *The Machine That Changed the World*, New York: Rawson; and Womack, J., James, and D. Roos (1996), *Lean Thinking*. New York: Simon and Schuster.

<sup>17</sup> See *The Bench Press* (Industrial Technology Institute, Ann Arbor), various issues.

<sup>18</sup> For the survey data, all differences between Northeast Ohio and other plants described below as "somewhat significant" have a probability of occurring by chance of between 5 and 10 per cent; differences described below as "significant" have a probability of less than 5 per cent. The Kruskal-Wallis test, a non-parametric version of the t-test, was used to determine statistical significance.

<sup>19</sup> For empirical evidence, see Susan Helper and Mari Sako, "Supplier Relations in Japan and the United States: Are They Converging?" *Sloan Management Review*, 36, no. 3, Spring 1995, pp. 77-84; Marvin Lieberman, Susan Helper, and Lieven Demeester, *The Empirical Determinants of Inventory Levels in High-Volume Manufacturing*, UCLA Anderson Graduate School of Management Working Paper, 1995.

chain on five dimensions: relations with customers and suppliers, production methods, relations with employees, performance measurement systems, and distinctiveness. We will draw on data from both the 1993 national survey and on our interviews.<sup>1</sup>

### **a. Customer Relations**

In contrast to the mass production philosophy, lean production emphasizes long-term, information-rich relations between customers and suppliers. These relationships allow suppliers to reduce waste by holding less inventory (because they are more sure of their customers' needs), by eliminating unnecessary process steps (because they can communicate with the customer about effective product designs), and by investing in efficient equipment and organizational practices (because commitment from customers allows them to have a longer planning horizon).

Looking first at the 1993 survey data, auto supplier firms in Northeast Ohio compare favorably with their competitors elsewhere in the US and Canada on a few measures. Northeast Ohio plant managers responded that their firms sold this product line to their important customers for about 5.5 years; plant managers elsewhere responded with an average figure of 4.8 years. Firms in our region also claimed that their customers asked for considerably less reductions in price (2.3% reduction in Northeast Ohio, and 3.5% reduction elsewhere).<sup>1</sup>

But the Northeast Ohio cluster lags behind suppliers located outside the region in the following areas.

*Information Exchange with Customer.* As table 6.1 shows, regional suppliers exchange far less information about products and processes with their customers. Regional plant managers felt that they have a weaker understanding of how their products are used in their customer's processes, both in 1989 and 1993. Although this understanding improved between 1989 and 1993, Northeast Ohio respondents registered a smaller improvement than elsewhere. Cleveland-area sales managers reported that their customers were more unreceptive to suggestions if these required process changes at the customer's plant; regional suppliers were also less likely to make suggestions.

Table 6.1. Information Exchange

Survey Question		Northeast Ohio	Elsewhere
Good understanding of how customer uses our product (1=strongly agree, 5=strongly disagree)	1989	2.3	1.8
	1993	2.1	1.3
Our suggestions unwelcome	1989	37%	22%
	1993	14%	2%
Unlike that we would suggest	1989	10%	8%
	1993	7%	2%
Prefer detailed contract (1=strongly disagree, 5=strongly agree)		4.2	3.7

*Suppliers' Perceptions about Customers.* Table 6.2 illustrates that Northeast Ohio suppliers were more wary of their customers than were their competitors elsewhere. Significantly fewer Cleveland-area sales managers felt that their customers treated them fairly compared with those outside the area. In specific terms, local sales and plant managers believed that both they and their customers were less willing to modify agreements if unexpected events occurred. They responded that their customers were less apt to help them in ways not required by contractual obligations. As a result, local firms were much less willing to make investments dedicated to their best customers on the basis of an oral promise. Only 10% indicated that they would do so because they trusted the customer to continue giving them business; nearly 30% of firms elsewhere were willing to do so. About a third of local suppliers were unwilling to dedicate equipment to their best customers because of "bad experiences with this customer in the past;" only 12% of sales managers elsewhere were unwilling to do so.

**Table 6.2. Suppliers' Perceptions of Customers**

<u>Survey Question</u>	<u>Northeast Ohio</u>	<u>Elsewhere</u>
Customer treats us fairly (1= strongly disagree, 5= strongly agree)	2.5	3.0
Willing to modify agreements (1= strongly disagree, 5= strongly agree)	2.5	3.0
Can rely on customer for help	2.7	3.0
Willing to make dedicated investment	10%	29%
Unwilling to invest because of past experience with the customer	33%	12%

*Customer Commitment.* Cleveland-area sales managers were much less confident that their customers would provide assistance to reduce price or to improve quality. In 1989 nearly half felt that their customers would switch immediately to a competitor offering better quality or lower prices instead of providing help. Only about a quarter of firms located elsewhere responded likewise. But two bright spots appeared here. First, the level of customer commitment to Cleveland-area suppliers increased between 1989 and 1993; less than a third of regional sales managers felt that their customers would switch immediately if a competitor offered better price or quality. Although local firms still lagged behind their national competitors, Cleveland firms registered a significant improvement. Secondly, fewer regional firms believed that their customers would hold them to the original price if their materials costs increased; this indicates some level of price flexibility on the customers' part.

Table 6.3. Perceived Level of Customer Commitment.

Survey Question		Northeast Ohio	Elsewhere
Customer would switch suppliers at end of contract on basis of price	1989	48%	27%
	1993	31%	18%
Customer would switch suppliers at end of contract on basis of quality	1989	48%	23%
	1993	31%	18%
Customer holds us to original price if our materials costs increase	1989	15%	31%
	1993	54%	61%

The 1996 interviews found continuing weakness in customer relations. Only 11 of thirty companies felt they had long-term relations (either contractual or implicit) with even their most important customers. Short time horizons were particularly felt by firms who were primarily second- or third-tier. Even those firms which did have long-term relationships with their customers typically did not offer such assurances to their own suppliers.

As reported above, few of the suppliers had regular discussions about product design with their customers, although several could cite isolated examples of such discussions being helpful. Many opportunities for mutual benefit were not taken advantage of. A striking example of this occurred at a firm which puts anti-corrosion and other types of coatings onto fasteners. Many of the parts require that a thin strip of coating be placed in a precise location. The firm's competitive advantage is that it has figured out how to use tumblers (big bowls of parts which are jiggled by an electric motor underneath) to orient the small parts so that the coating can be applied by machine rather than by hand. In one case we observed, engineers were trying to figure out how to automate the coating of a part which was almost, but not quite, symmetric. They were working on special feeder trays, and talking about machine vision systems, but had not asked the customer if it would be possible to change the design of the part to make it easier to orient. When asked why they hadn't discussed the matter with the customer, they said they didn't think the customer would be interested, because other coaters wouldn't have the same process. (In most cases, the coating firm doesn't receive any contracts for its work; when it receives a batch of parts from a customer, there is no guarantee that the customer will send another one.)

One reason for the lower levels of commitment and information flow between suppliers and customers in Northeast Ohio is the minimal presence of Japanese customers in suppliers' order



books. Only one firm had substantial Japanese business; two other firms had recently obtained small orders from Honda of America. This percentage (10%) of firms with Japanese customers is substantially below that found in the 1993 survey (over 50%). In both the survey and the interviews, firms with Japanese customers reported substantially more frequent visits, discussions about the design of the product and process, and expressions of long-term commitment if performance goals were met.

### b. Production Methods

According to the survey data, Cleveland-area suppliers lag behind firms in other parts of the country in two key areas.

*Manufacturing Technology.* The results given in Table 6.4 show that Northeast Ohio auto suppliers use older machinery; employ less automation like computer numerical control (CNC), programmable logic controllers (PLC's); and robots. CAD drafting is also less common among regional firms. But Cleveland-area companies improved significantly between 1989 and 1993, especially in the use of PLC's. (We did not systematically collect this data during the 1996 interviews.)

**Table 6.4. Manufacturing Technology**

Survey Question	Northeast Ohio	Elsewhere
# Machines < 5 years old	20.0	38.0
# Future machines w/ CNC	1.0	15.0
CAD drawings (1=0%, 6=81-100%)		
1989	1.3	2.1
1993	2.8	3.7
PLC's in use (1=0%, 5=76-100%)		
1989	2.2	2.7
1993	3.3	3.5
<b>Has no PLC applications</b>	<b>30%</b>	<b>15%</b>
Robots in use (1=0, 5=over 10)		
1989	1.4	1.9
1993	1.9	2.5

*Inventory.* Northeast Ohio plants shipped larger lots to their customers than suppliers in other parts of the country. In 1989, local suppliers shipped about the same lot sizes as did firms located elsewhere. By 1993, Cleveland-area firms shipped about two days' less product, but

companies outside the region improved by almost seven days. Local sales managers also expressed more dissatisfaction with customers' requirements for Just-In-Time (JIT) delivery. They also considered inventory reduction in 1989 less important as a key factor for success, but in 1993 they and their national counterparts viewed it as equally important.

**Table 6.5. Inventory and Delivery**

Survey Question		Northeast Ohio	Elsewhere
Produced lot size in days	1989	21.4	22.2
	1993	19.6	15.6
JIT only transfers inventory responsibility to supplier (1=strongly disagree, 5= strongly agree)		4.0	3.3
JIT does not increase our costs (1=strongly disagree, 5= strongly agree)		2.6	3.3
Importance of inventory reduction (1=less important, 5= extremely important)	1989	2.8	3.2
	1993	4.3	4.2

Based on our interviews (and random checks of dates on shipping labels during plant tours) we would classify seventeen of our 30 plants as fairly effective inventory managers, in the sense that they kept one week or less of most types of raw materials, work-in-process, and finished goods inventory. Another six were working toward this goal, while seven were not making efforts in this direction.<sup>20</sup>

- Fifteen companies are “lean” by this measure.
- Six companies are “somewhat lean” by this measure.
- Seven companies are “not lean.”

### c. Quality Assurance

Due to the wide variety of products produced by the automotive supply industry, we were not able to compare levels of quality performance. However, we were able to look at some more indirect indicators. Table 6.6 presents the views of plant managers on the importance of quality assurance both to their own firms and to their customers. Suppliers from Northeast

<sup>20</sup> We included the service suppliers in this measure, because they maintain stocks of raw materials (and often work in process as well).

Ohio felt somewhat less strongly than their national counterparts that lower defects mean lower costs. Fewer Cleveland-area firms used data regarding past sources of defects to improve current production processes. That is, area firms were more likely to be obtaining high quality through inspection, in which a higher level of quality requires more inspectors, which leads to higher costs. In contrast, methods such as statistical quality control allow a plant to prevent defects from occurring by collecting data on past conditions which have produced defects, and using that data to change the process to avoid such conditions. Typically these methods allow both costs and defects to be reduced, due to reduced waste in scrap and rework.

**Table 6.6. Quality Assurance Practices**

Survey Question	Northeast Ohio	Elsewhere
Lower defects means lower costs (1=strongly agree, 5=strongly disagree)	1.7	1.4
Rarely use defect data for modifications (1=strongly agree, 5=strongly disagree)	3.8	4.4
Customer charges penalty for defects in shipments		
	1989	25%
	1993	70%
Customer wants proof that root cause of defect was corrected		
	1989	30%
	1993	75%

Customers of Northeast Ohio parts plants were more apt to penalize their suppliers for defects than to assist them in improving quality in the future. In 1989, customers of Northeast Ohio firms and firms located elsewhere were about equally likely (25%) to assess financial penalties for defective shipments. But by 1993 over two-thirds of suppliers in the region, as opposed to less than half of suppliers elsewhere, reported that customers charged such penalties. In both 1989 and 1993, significantly fewer firms in Northeast Ohio were required to provide their customers proof that they had corrected root causes of defects. For example, in 1993, only 43% of Northeast Ohio suppliers had to provide such proof, but 88% of suppliers elsewhere did.

To categorize our interview results, we used a relaxed definition of 'leanness' with respect to quality method. Companies are considered "lean" if they have in place quality control measures such as SPC and root cause analysis. Having numerous quality awards also suggested leanness. Companies were grouped as "somewhat lean" if they were putting in

place a quality tracking method, if they had a method that was not particularly effective, or if they had only made modest efforts to track and improve quality. Finally, "not lean" companies were those who had no quality tracking methods.

- Seventeen companies were considered "lean" by this measure.
- Ten companies were considered "somewhat lean" by this measure.
- Three companies were considered "not lean."

Only 20% of the companies had achieved QS9000 certification by fall 1996. (See Appendix).

#### d. Work Force

Survey results suggest that Cleveland auto suppliers invest much less time and money in their workers than do firms outside the area. Despite perceptions that Northeast Ohio is a high-labor cost area, Cleveland-area workers received lower wages than workers at auto suppliers elsewhere. They also received less training, and management placed less emphasis on their involvement in important work processes.

*Wages and Profit Sharing.* According to table 6.7, unskilled and semiskilled workers in Cleveland auto parts plants received nearly \$2 per hour less than their counterparts in other locations. Skilled workers received almost \$3 less. Regional firms were less likely to increase wages between 1989 and 1993; only 15% offered profit-sharing to the factory floor, as opposed to 37% for firms outside the region.

Table 6.7. Average Wages.

Survey Question	Northeast Ohio	Elsewhere
Unskilled/semiskilled hourly wages, 1993	\$8.36	\$10.04
Change since 1989 (1=10% increase or more, 2=0-10% increase, 3=decrease)	1.6	1.3
Profit sharing for unskilled/semiskilled	15%	37%
Skilled hourly wages	\$10.91	\$13.69
Change since 1989 (1=10% increase or more, 2=0-10% increase, 3=decrease)	1.6	1.2
Profit sharing for skilled	15%	38%

*Employee Training.* Cleveland firms devoted dramatically less time to training new hires and experienced workers, both formally and informally. Table 6.8 presents the results.

**Table 6.8. Employee Training.**

Survey Question	Northeast Ohio	Elsewhere
Formal training for new hires (hours per year)	15.9	37.6
Informal training for new hires (hours per year)	34.0	70.6
Formal training for experienced workers (hours per year)	9.6	47.0
Informal training for experienced workers (hours per year)	10.2	104.8

*Employee Involvement.* As Table 6.9 shows, in 1989 Northeast Ohio managers felt it slightly less important to increase employee involvement than managers at firms outside the region, but by 1993 they placed as much emphasis on it as their national competitors. Quality circles in Cleveland-area suppliers exerted significantly less influence on work methods and safety/health policies. Unskilled employees in the region's plants had less opportunity to interact with personnel from customers.

**Table 6.9. Employee Involvement.**

Survey Question	Northeast Ohio	Elsewhere
Importance of increase employee involvement (1=less important, 5= extremely important)		
	1989	3.1
	1993	4.5
Quality circles influence work methods	50%	68%
Quality circles influence safety/health	40%	63%
Unskilled employees interact with customer	30%	54%

Once again the same labels were used with respect to employee relations and involvement with the production process. Companies called "lean" engage in cross training, involve employees in production through quality circles and other such structures, have in place incentive programs or profit-sharing, and generally encourage employee input. Companies

were considered “somewhat lean” if they were just beginning to adopt such practices or if they involved employees to a more limited extent. Companies considered “not lean” by this measure do not involve employees at all. They tend to have high turnover rates and use unskilled labor. Only two of the plants we visited were unionized; one of these facilities was in the ‘somewhat’ category (except for an exemplary unit described below), and the other was not lean.

- Nine companies were considered “lean” by this measure.
- Fourteen were considered “somewhat lean.”
- Six companies were considered “not lean” by this measure.
- There was one “don’t know.”

Two companies stood out for their extensive employee involvement programs.

#### **e. Performance Measurement**

Managers are beset by uncertainty about the extent to which their actions really contribute to their firm’s goals (be they maximizing profit, growth, and/or community welfare, etc.) Mass production assumes that measuring direct labor time is a good proxy for how well the firm is controlling its costs. Since this is what is measured, managers work hard to reduce direct labor--even if it means adding cost somewhere else. By contrast, lean production techniques have a different, and much less financially-oriented, underlying philosophy. For example, Ohno believed that inventory is costly far beyond the easily-measured expenses of storage and working capital. In addition, excess inventory leads to lower quality, for two reasons. First, defects are found long after they are caused, making it harder to trace their cause. Second, inventory allows mistakes to be covered up, making it possible to avoid fixing their root cause. Therefore, according to the Just-in-time philosophy, firms should not calculate an ‘economic order quantity’ and stick to it; instead they should work to continually minimize the amount of inventory they hold.<sup>21</sup>

The broad view of waste described in the introduction to this report also poses challenges for performance measurement. Often, pollution minimization expenditures are put into overhead. Under these circumstances, customers have less incentive to invest in pollution-prevention activities at their suppliers. For example, one firm described how Honda's requirement that a part pass a 1000-hour salt spray test forced the supplier to use toxic chemicals for electrocoating it. Other automakers were content with a 100-hour requirement that could be met using non-toxic processes. However this firm does not have a system for tracking the extra costs of the toxic process throughout the plant.

Few of our interviewees (typically environmental and production managers) could clearly describe how their plant's performance was measured; most of those who ventured a guess mentioned some mix of maximizing output and minimizing defects. Activity-based costing is

---

<sup>21</sup> For an insightful treatment of JIT, see R. Schonberger, *Japanese Manufacturing Techniques*. New York: The Free Press, 1984.

a system which allocates costs (even overhead costs) according to where they are incurred; it is able to go beyond the simple assumption that all projects incur a similar pollution-control expense. Not one of our interviewees mentioned that their plant had such a system.

One performance measure which is useful to the local community is sales and job growth. At the time of our interviews in summer 1996, twenty of our thirty companies were experiencing increasing sales. However, four companies are growing in sales, but report varying margins or decreasing numbers of employees, and one company reports growth, but notes that it comes in the wake of a recent downsizing.

Three companies are running at full capacity (and have been for awhile; seems to be no plans or possibilities for expansion).

Six companies report that they are static or shrinking. For one company, no information exists about growth.

The result that only half of the companies are growing in both employment and profitability at a time of economic boom is a worrisome trend.

#### **f. Distinctiveness**

We looked at two measures of distinctiveness: the complexity and proprietary nature of the firm's product or process, and its design capabilities. The survey shows that although the region's companies produce less complicated and cheaper components, their design capabilities seem to be improving steadily.

*Nature of Product.* As Table 6.10 shows, Northeast Ohio suppliers produced somewhat simpler and less costly parts than firms outside the region. Local firms also felt that improving quality was less important as a key factor for success.

**Table 6.10. Nature of Product.**

Survey Question	Northeast Ohio	Elsewhere
Technical complexity of product (1=fairly simple, 5=highly complex)	3.2	3.5
Average piece price of product (1=less than \$1, 5=greater than \$100)	2.0	2.3
Importance of improving quality (1=less important, 5=extremely important)	3.6	3.9

*Product Development Process.* Northeast Ohio firms contributed significantly less engineering hours on product development for previous models, but as table 6.11 shows, area suppliers accounted for a great deal of the engineering on the present design and recent design changes.

**Table 6.11. Product Development Process.**

Survey Question	Northeast Ohio	Elsewhere
Customer did most of engineering, previous model	47%	27%
Contract firm did substantial engineering, previous model	10%	3%
Both contributed equally to present design	33%	21%
Our plant/firm did most engineering on last change	90%	73%

Eleven of the companies we interviewed claim to have distinctive features that severely reduce or eliminate competition. The most common reasons given for distinctiveness were the ability of the company to make specialized or very high quality parts and the possession of a proprietary process or product. Less frequent explanations of distinctiveness were the large size of the facility (large volume of production) and ability to do small batches.

Six companies have proprietary processes or make a patented product, although two of those are currently engaged in litigation to try to protect their patent.

In terms of location of design work, several categories were considered. Eight companies say that their customers hand them specifications. Four of these proceed to design the production process to make the part to the customer's specification. There are four additional companies that design processes in-house, three of which say that other design work takes place at headquarters, and one of which says that product design is collaborative. Two companies complained that customers do not fully utilize the company's ability to do engineering design.

Many companies locate design facilities at a headquarters rather than associating design with the production floor. Twelve companies in this dataset (43%) named headquarters as the location for design work. Of these, four claimed to collaborate with customers or suppliers in the design process.

In total, 15 companies in the dataset (50%) collaborate with customers or suppliers in design. Only four companies conduct design entirely in-house, and half of these do so because of their proprietary process.



## B. CAN GREEN BE LEAN?

A recurrent theme in environmental management is its cost. It is frequently assumed that various pollution prevention and waste management efforts- ranging from end of pipe clean-up to comply with regulations to environmentally enlightened design-is costly. The conclusion many arrive at is that "good" environmental management puts firms at a relative cost disadvantage in comparison to firms which are not constrained by EPA regulations and environmentally friendly objectives.

In contrast, research by Prof. Richard Florida attempts to link "good" environmental management practices to competitive advantage.<sup>22</sup> He argues that pollution prevention and waste management efforts, since they effectively reduce waste and increase efficiency within the firm, have met positive results for the practicing firm(s).

We analyzed the firms in our sample with respect to the two sets of practices: Leanness and Greenness. Each category was defined using the criteria described earlier in this report. A firm received two points for each category in which it was lean, and one point for being 'somewhat lean'. A firm also received two points for each of the following pollution-control activities: recycling, end-of-pipe, systematic effort, and three points for prevention. Each firm's greenness score was then weighted by its degree of liability, so that firms with lower liability were not penalized for not undertaking as many activities as firm with high liability. After every firm was assessed with respect to its leanness and its greenness, the firms were rank ordered to distinguish the most lean from the least, and the most green from the least.

All the firms in the sample over the median level of 'green' were then categorized as green and all the firms in the sample over the median level of 'lean' were then categorized as lean. This methodology enabled us to empirically test whether a disproportionate number of firms were green, but not lean OR lean, as well as green.

The table follows:

		Lean	
		0	1
Green	0	8	7
	1	7	8

Our results show an equal distribution of firms in each quadrant of the table. This demonstrates no appreciable bias across the categories lean and green, lean, but not green, green but not lean, and neither lean nor green.

---

<sup>22</sup> Richard Florida, "The Environment and the New Industrial Revolution", forthcoming *California Management Review* 1997.

Thus, we note that all categories appear equally likely. Being green neither precludes running an efficient and lean operation, nor causes it. In our interviews we came across examples of lean being a complement to green, as in the effect of housekeeping on quality and productivity. We also came across examples of leanness being in conflict with greenness; most of these occurred due to the 'lean' tenet of being sure to meet customer desires for quality and durability, even if that means extra (non-returnable) packaging, or more toxic chemicals used to achieve a greater degree of rust-proofing.

While this finding supports neither side of the above mentioned controversy, the lack of linkage between lean and green is a hopeful sign in the sense that efforts to become green are not necessarily bad for business.

CAMP can use this approach to assuage the fears of potential partners in waste reduction projects.

## CHAPTER VII

### How Firms in the Northeast Ohio Automotive Supply Chain Can Work More Effectively Together

Many 'successful' manufacturing regions suffer from a high degree of air, water, and soil contamination, due to the density of polluting firms located there. However, the evidence presented in the previous chapter suggests that lean is not necessarily inconsistent with green. In this section, we explore the possibility that more efficient manufacturing practices and reduced pollution might both be more effectively sought when firms are located close together.

By leveraging their own distinct advantages of natural resources, educational institutions, cultural heritage, infrastructure, and historical legacies, many regions tend to specialize. For example, New York City has become a center for banking and finance; Boston has a wealth of educational institutions along with high technology industries; thousands of companies involved in the computer industry are located in the silicon valley region of northern California.

Northeast Ohio is only part of a larger automotive agglomeration that encompasses a large portion of the midwestern United States. This geographic clustering of producers and suppliers--centered in southeastern Michigan and extending into Indiana, Ohio, Illinois and Wisconsin--has been an enduring feature of the US automotive industry. For many decades, industrial activity tended to congregate in central locations in order to minimize transportation costs and gain access to large labor pools. Easy access to large markets via water and rail (in addition to a large home market) and the ability to achieve economies of scale favored the growth of large industrial cities such as Cleveland. However, as the costs of transporting products have dropped, the economic role of geography has shifted. While the costs of transporting products may have fallen, the benefits of proximity in facilitating chance encounters which lead to the development of new ideas and in making coordinated changes remain. Today's high functioning regional economies feature substantial amounts of cooperation that can facilitate a rich exchange of ideas and information between suppliers, customers, and competitors.<sup>23</sup> Agglomeration of related firms and supporting industries can be advantageous because it can increase the number of contacts--either formal or informal--of a diverse group of workers. Common ties in schooling, civic activities, churches, and social circles often can overlap with business relationships, leading to more fluid communication and trust within an industry cluster. In theory, this dynamic will eventually speed the rate of technological innovation and adoption throughout the region.

It is perhaps useful to array the benefits of agglomeration on a two by two matrix. Consider the following:

---

<sup>23</sup> See for example, Annalee Saxenian, *Regional Advantage*. Berkeley: University of California Press, 1993, for a discussion of the role of proximity in encouraging innovation in Silicon Valley.

### Types of possible interactions in agglomeration economies

	Coexistence	Discussion
Same Supply Chain	I	II
Different Supply Chain	III	IV

In the above matrix, type I firms economize on transportation costs, share a common, skilled workforce, and sustain an array of relatively specialized support industries. They can achieve these benefits without directly communicating with one another. Type II interactions enjoy the benefits of a large, urban area such as a large pool of managerial talent from other industries, high quality legal and accounting services, access to government offices, and the ability to recruit the best talent from local colleges and universities, along with a superior transportation and communication infrastructure. Firms in the third and fourth categories achieve benefits from proximity to each other because they have developed formal and informal channels of communication between firms in the same (III) or in a different supply chain (IV). Strong trade or business organizations that attract local executives, engineers, or managers may be one example; country clubs, churches, popular restaurants, and alumni organizations may serve a very similar function. What is most important is that the innovations and improvements of firms within the same or different industries become more transparent to one another, eliciting a richer and more cooperative dialogue that can increase productivity within the entire region. In a local culture that promotes innovation of all types, environmental performance is also likely to be enhanced.

The following analysis will discuss the northeast Ohio automotive supply chain using the four categories of the above matrix. From the outset, it should be noted that the origins of the Cleveland area automotive industry is firmly rooted in the type I interactions of co-existence within the same supply chain. Yet any evidence that our sample firms regularly discuss improvements with each other would bode well for the region. The contrast between "Coexistent" and "Discussion" type firms should be an instructive tool for future policy within the region.

#### **Type I: Coexistence Within the Same Supply Chain**

Of the four types of interactions that are possible within an agglomeration economy, Type I (Coexistence within the same supply chain) best characterizes the traditional industrial cities of the Midwest. In the late 19th and early 20th centuries, these locations benefitted from economies of scale in transportation via established water and rail lines that connected the Midwest to the population centers in the eastern United States. Because of their relative proximity to large stocks of raw materials (e.g., hardwoods and iron ore), cities along the Great Lakes such as Cleveland, Detroit, Chicago, and Buffalo became excellent sites for a new age of mass production. Despite the fact that the transportation considerations that initially favored the Midwest have changed dramatically during the last several decades, there continues to be a substantial concentration of automotive employment in the region (though many of the new factories and employment are now of the periphery on the traditional urban cores). In short, historical circumstances and accident may be important reasons for the explaining the persistent geography of the automotive supply chain.

In many instances, it was apparent from our interviews that the firms' current location was not based on any assessment of economic or regional advantage. One of the primary reasons given for being located in northeastern Ohio was that the founders of the company had originally resided in the area. Overall, approximately 30 percent of our sample indicated that company history accounted for their current location in northeast Ohio; the managers and executives of these firms were unaware of any intrinsic advantages that the NEOH region offered over other parts of the U.S.

Nevertheless, as the economist Paul Krugman observed<sup>24</sup>, the clustering of similar and related firms has been a longstanding feature of our industrial landscape. Although the reasons for the initial grouping may be traced back to "some seemingly trivial historical accident," these regions nonetheless develop a competitive advantage that eventually becomes self-sustaining. There are two features of agglomerations which facilitate this trend, even if the firms do not directly communicate with each other:

- 1) Pooled labor markets allow firms and individuals with specialized skills to efficiently move between one another, benefitting both firms and workers;
- 2) Firms producing specialized inputs flourish in the same location through increased economies of scale, thereby improving the downstream product while keeping transportation costs low.

Drawing on this framework, the viability of the northeast Ohio automotive agglomeration should be judged in part based on firms' access to a common workforce that has developed specialized skills and knowledge. However, in the course of our interviews, which vigorously probed the topic of location and strategy, only one firm explicitly listed the quality of the local workforce as part of their competitive advantage. In contrast, there were several firms that felt that their current location gave them access to relatively inexpensive labor (approximately \$5 to \$8 per hour). This was particularly true with companies on the periphery of the Cleveland metropolitan area, where managers often hired production workers who were

---

<sup>24</sup> *Geography and Trade*. Cambridge, MA: MIT Press.

reluctant to commute to the major cities in the region. Although the work ethic of rural workers in his area was praised by one manager, difficulty in attracting high-quality local employees was given as a drawback<sup>25</sup>. Absenteeism and high turnover rates were mentioned by managers of other low-wage firms. In theory, Northeast Ohio's longstanding presence in auto-related industries and recent downsizing should have made specialized workers especially plentiful. Ironically, many employers in the metalworking fields complained of a lack of machinists and tool & die workers. The relative scarcity of these tradespeople had actually become a disincentive to training since a worker could easily be hired by another regional employer for a slight pay premium.

Advantages due to access to specialize inputs were more evident than those of access to pooled labor markets. Of the 30 firms surveyed, five companies could be identified as service providers whose growth was dependent primarily on other manufacturers in the region. (The service providers included a coater, a heat treater, and a waste management firm.) Most of these companies provided specialized industrial processes on intermediate goods enroute to another business. Because the value of these goods may not necessarily be dramatically enhanced (e.g., rolled steel that is slit to a specific dimension), transportation costs still remain an important consideration; thus, finding vendors in close geographic proximity is still important.

Many managers commented that Cleveland did have a relatively large array of supporting firms. One manager of an aluminum casting company reported that the quality of vendors in the region improved his company's performance, though he often had to get a tool & die contractor from Pennsylvania because "the local ones were always swamped." However, an executives from a stamping plant commented that the quality of these support industries--particularly platers and coaters--should be much higher considering the volume of work in the area.

Among the firms that had a significant market outside Northeast Ohio, only two indicated that northeastern Ohio provided them with a competitive advantage in terms of transportation. One of these firms was a stamper that utilized local vendors for plating and coating of his parts. The other company supplied seats (a very bulky item) to a local automotive assembly plant. They had recently built the northeastern Ohio facility in order to ensure more timely deliveries to their major local customer. Although one of the executives for this firm praised their new location, the plant was also described as "portable"--i.e. it has a leased building, a centralized headquarters in another city, and a professional management staff.

Despite comments by several managers and executives that discounted the strategic important of their Northeast Ohio location, there was substantial evidence to suggest most production facilities were "portable" only within certain limits. For example, many of firms interviewed agreed that being in the Midwest gave them excellent access to a large number of potential customer and suppliers. Because of the growing emphasis on just-in-time production and

---

<sup>25</sup> In several of these firms, the difficulty in finding workers may well have a lot to do with the low wages being offered. One firm wanted to find high-school graduates who could pass a literacy and math test, and do heavy lifting in a hot environment, all for \$6.25 per hour.

delivery within the automotive industry, another strategic consideration--on top of a Midwest location--was relatively easy access to major highways. With the current interstate highway system, transportation costs were cited neither a significant limitation or advantage to the continued growth of most northeast Ohio suppliers.

Japanese firms have wanted to gain the benefits of low transportation costs and access to specialized training available in the midwest. However, they have also wanted to avoid what they perceived as the diseconomies of the traditional auto agglomeration --unions and a mass production philosophy. According to James Rubenstein, "Ohio [is] the state with the largest number of Japanese components supplier. Historically, two-thirds of Ohio's automotive suppliers concentrated in the northern fourth of the state, a 75-km corridor north of US Route 30 and south of Lake Erie and the Michigan State line . In contrast, Japanese firms have shied away from northern Ohio, as only eight of the state's first forty Japanese suppliers located north of US Route 30. Furthermore, only one of the plants is located east of the Columbus metropolitan area."<sup>26</sup> From the perspective of Japanese suppliers, the advantages of this strategy are manifold: they can avoid the wage premiums and inflexible job classifications that they believe go with unionized labor; they enjoy increased bargaining power from being one of the few employers in a small local market; just-in-time delivery can be maintained through the close proximity to interstate highways; and managerial talent and institutional support in the form of vocational schools and colleges can be drawn from adjacent metropolitan areas.

Moreover, as many industry analysts have noted in recent years, this locational option is also open to domestic suppliers. Two companies we interviewed had relocated from the Cleveland area to less populous locations in the region in order to avoid labor unions and keep labor costs low. Similarly, two other auto suppliers in the sample had relocated some of their plants from the eastcoast to Northeast Ohio in order to improve production and delivery to their large Midwest market; both firms located in exurban areas, however, and in the process of their move were able to reduce labor costs. Finally, one executive, whose firm was located in a county adjacent to Cuyahoga County (where Cleveland is located) for over thirty years, stated that his semi-rural location was good because of the large supply of inexpensive labor.

Though many auto suppliers are now moving away from traditional manufacturing hubs, they still remain within the Midwestern automotive agglomeration and suffer relatively few logistical or communication problems. In short, the type I interactions of coexistence within the same supply chain may describe benefits that accrue to firms that are more spatially scattered than in earlier years.

Many cities in both NEOH and throughout the country have entered into a bidding war to attract businesses such as auto suppliers with offers of tax abatements and infrastructure improvement. However, a vital automotive agglomeration that generates premium wages for workers requires the ongoing creation a flexible and skilled workforce. Moreover, there needs to be culture of innovation that gives auto suppliers in NEOH a regional advantage.

---

<sup>26</sup> Rubenstein, James. *The Changing Structure of the US Automobile Industry*. New York: Routledge, 1992.

Evidence from the CAMP-REI project suggest that mere coexistence within a region can no longer guarantee a strong presence in the auto supply chain.

### Type II: Coexistence With Different Supply Chains

One of the benefits commonly associated with agglomeration economies is the ability of knowledge workers--for example, managers, accountants, or engineers--to fluidly shift between a multitude of industries. Often innovations may have great transfer potential to field that are only marginally related. Therefore, a large number of diverse specialities located in an urban area can provide the medium for faster dissemination of ideas. Type II interactions are economies of urbanization that result from the coexistence of different industries in the same geographic region. Because it has a diverse employment base that includes a large array of educational institutions, it is likely that Northeast Ohio offers its automotive suppliers urbanization benefits that are comparable to those found in other industrial cities in the Midwest. During our interviews, no auto-supplier executive explicitly stated that proximity to Cleveland or Akron area provided his company with a competitive advantage. However, many of the people we interviewed did receive an education at Case Western Reserve or Cleveland State University. A few firms took advantage of vocational programs offered by community colleges.

### Type III: Discussion Within a Supply Chain

We found relatively few examples in this quadrant—but a great deal of potential. One firm moved here from New Jersey to facilitate better communications with customers and suppliers; "Big customers are within a two-hour drive." This feeling was echoed by a number of other firms we interviewed.

The best example we found of "friendly competition" as the manager of one of the firms described it, was between two stamping firms with long-time family ties. While this manager has chosen to focus on Big 3 business, the other firm has become a major supplier to Honda. From these discussions he has gained insight on how Japanese automakers operate. Because he feels proximity facilitates communication, he explicitly prefers local suppliers and will work with them to improve quality.

Another firm developed an environmentally safe lubricant that is used during the injection molding process of aluminum casting. Key to the success of the project was an informal and cooperative arrangement, who were his customers; he joked about the number of his "ideas from golf partners." He credits his Cleveland ties with his international success. His engineers belong to local trade groups.

Since locating its facility here in 1977, a German has tried to establish ties with local university and trade schools to better serve its own needs (and reproduce some of the agglomeration economies of its home base).. The firm has done a joint venture with a local company and has a cooperative relationship in Columbus that has enabled the firm to get superior alloys to meet its specifications.



**Type IV: Discussion Across Supply Chains**

One firm had taken a great deal of advantage of specialized institutions available in Cleveland. The owner has a brother who works at the large NASA laboratory on the west side of Cleveland; he was able to program the firm's CNC machine at no charge. The owner, who is a graduate of Case Western Reserve University also started a joint venture with a CWRU professor who is a material specialist. (Ironically, the owner says that all he needs is a UPS pick-up site and that he would consider relocation to another region if he could be assured better--not necessarily cheaper--labor.) One other firm cited technical assistance from local universities as a benefit of being located in Cleveland, only 20 minutes from Case Western.

**Conclusion: Clustering is an Unrealized Potential**

The examples presented above show that Northeast Ohio firms have the potential to use their proximity to facilitate waste reduction in two ways. Both would involve somewhat more discussion with each other than now occurs on a regular basis. The first way is simply to get together more often with customers and suppliers to discuss these ideas. The second way is to coordinate production schedules better to minimize inventory. Reduced inventory means less waste due to packaging. Also, if parts will be used soon after they are made, less lubricant is necessary to protect them from rusting. Parts get less dirty, so they need less washing, so use of cleaning chemicals is reduced.

## Chapter VIII Recommendations

Based on our research, we have a number of suggestions about how CAMP might help the Northeast Ohio automotive supply chain become more healthy in financial, employment, and waste-reduction terms.

First, the report identified a number of strengths that area firms have. Many of them have distinctive products, and they are located near their customers and suppliers. In some cases, customers and suppliers have begun to have discussions about ways to modify products and processes in order to reduce waste.

The relatively dense network of auto suppliers also puts the region a good position to meet ever-more stringent environmental regulations. The reason is that stricter environmental regulations generally make a process more difficult to operate, meaning that firms would like to delegate it to specialist suppliers if the process is not core to the firms' business. Stricter environmental regulations also make it more difficult for in-house operations to obtain economies of scale. The reason is that several new environmentally-friendly processes are usually needed to replace one heavily polluting one, depending on the exact function of the product. For example, one of the platers we visited now used a 'seventh generation' process which used no toxic chemicals for interior parts, another process with some toxicity for intermediate parts, and a process with cyanide for the parts which needed maximum rustproofing. Ten years ago, the cyanide-based process would have been used for all parts.

Such providers of specialized services will be more plentiful and more able to operate at efficient scale if there are many firms in the same industry. Thus, the concentration of specialist platers, heat treaters, and waste management firms in Northeast Ohio is a source of strength for the region that will probably become even more important in the future.

However, the report has also identified a number of serious weaknesses in the Northeast Ohio automotive supply chain. Firms in the area have been slow to adopt lean production methods. They are less likely to have a role in product design, their products are older and less complex, they deliver to their customers in larger batches, and they learn less from their suppliers, customers, and shop-floor workers than do their rivals in the rest of the United States and Canada. None of them have a fully-integrated approach to waste management, and some are barely in compliance with environmental regulations.

Below, we identify a number of ways in which CAMP can help area firms build on their strengths to assure a viable automotive supply chain in the future. The key goal should be to establish an attitude of continuous improvement both within and between firms. Half a century ago when transport costs were high, a region could prosper due to agglomeration economies of coexistence. Now that transport costs as a percent of total costs are lower, coexistence is

insufficient to assure prosperity.<sup>27</sup> Instead, the region needs to work on taking advantage of the lower costs of face to face communication which agglomeration provides.

Below are three areas in which CAMP might go about establishing an attitude of continuous improvement. In all three areas, CAMP should look for initial projects that are small enough to be done in an integrated manner. That is, they should initially focus on one line within a plant or one example of interaction between a customer's part and a supplier's part, and make changes on a micro basis to a variety of policies affecting that one project. This approach avoids the difficulty of across-the-board changes to just one policy, which may have the effect that improvements on one dimension (e.g. reduced inventory levels) can have the initial impact of reducing performance on other dimensions (e.g. delivery reliability or responsiveness to customer schedule changes).

That is, project selection will be key to CAMP's degree of success. The early projects should be integrated (as discussed above), so that barriers to success can be removed, whether they emanate from shopfloor layout, accounting systems, human-resource policy, or other sources.<sup>28</sup> Finding such projects will depend on getting detailed information from someone in the firm who is familiar with current issues in a plant. Our interviews suggest that the environmental manager could be such a person. In contrast to warnings we received when we began the project, these managers do not feel that everyone who asks them about waste issues is a potential informant for the EPA. Rather, they feel that the EPA already knows about them; their bigger worry is that due to their own lack of influence within the firm (and in some cases lack of training) the firm will be shut down by the EPA and the environmental manager will be blamed. Some of the managers also recognized the potential of the waste prevention concept to increase their influence within the firm, since they could suggest changes that would reduce costs, not just add to them.

This consideration suggests that CAMP might think about a team approach to pollution prevention, since (as discussed below) expertise in accounting, operations, and environmental management will be needed. We suggest that CAMP consider projects at three levels of the supply chain:

---

<sup>27</sup> The automakers' desire to reduce inventory offsets the reduced transportation costs somewhat. However, the industry has continued to decentralize away from its southeast Michigan-northeast Ohio axis, since the automakers' delivery requirements can easily be met by any supplier plant less than a day's drive away from the assembly plant. This means that assembly plants in Michigan can be supplied by plants as far away as Tennessee.

<sup>28</sup> This is the key insight of Honda's "BP" program, which has been successful in improving suppliers' cost, quality, and delivery reliability.

## 1. Within firms

### a. change performance measures.

Firms need to develop the ability to attribute costs to processes.<sup>29</sup> In many firms, pollution clean-up was charged to overhead. Therefore, the impact of prevention activities on a particular product's cost was understated, since the pool of savings was spread across all of the firm's products.

### b. train managers as well as workers.

As discussed in Chapter VI, establishing a framework for continuous improvement and waste reduction is a managerial responsibility. Even if, for example, shopfloor workers were trained to analyze the root cause of defects, this training will be wasted (and will eventually be forgotten) if there is not an organized program. A good example of labor-management cooperation in establishing and following through on training programs in areas such as QS9000, continuous improvement, and health and safety is the Labor-Management Council for Economic Renewal in Taylor, Michigan.

### c. choose relatively high-payoff projects first.

Some firms will be more receptive to pollution prevention efforts than others. Based on the framework outlined in Chapter V, we suggest that CAMP's initial efforts be focussed on those firms where pollution generating activities are strategically important, but cause moderate to low liability. The reason is that these firms are less likely to have thought about pollution minimization in a systematic way, and also are less likely to be worried that the transition to a new approach might lead to the firm falling out of compliance with environmental regulations.

## 2. Between suppliers and customers.

### a. find customers who are skilled at waste reduction.

Customers are an important source of motivation for suppliers to improve, since the customer can provide powerful incentives (like more or less business) for performance. These incentives are difficult for an organization like CAMP to provide.<sup>30</sup> Unfortunately, firms in this area do not receive much help on waste reduction issues from their customers.

One of the striking findings of our interviews was the small proportion of Northeast Ohio firms who had Japanese customers. This is unfortunate, because these customers usually push their suppliers to reduce wasted production effort, and in many cases provide effective technical assistance. Honda of America's three US plants are located less than three hours away, and Auto Alliance (Ford/Mazda) is only two hours away. In addition, Cleveland is home to the headquarters of several major first-tier auto suppliers (TRW, Parker-Hannifin, Eaton, and Timken), yet there was only one mention of one of these firms (Timken) as either a

---

<sup>29</sup> Activity-based costing is a useful tool for doing this. For an introduction, see Barry J. Brinker, *Emerging Practices in Cost Management*. New York: Warren, Gorham & Lamont., 1991.

<sup>30</sup> See Celeste and Sabety, Ltd. "Honda of America Mfg, Inc. An Industrial Model of Technology Transfer: Transforming a Network of Automotive Suppliers", Columbus, Ohio, 1994, and John Paul MacDuffie and Susan Helper, "Creating Lean Suppliers: Diffusing Lean Production Through the Supply Chain", Wharton School Working Paper, 1996.

customer or a supplier to our interviewees. A useful activity for CAMP might be to interview these firms to ask them why they don't have more suppliers in the area. If the lack of suppliers is based on misconceptions, then these can be aired and remedied. If there are systematic weaknesses among Northeast Ohio suppliers, these interviews can be an important source of data about them.

b. encourage suppliers to consider pollution prevention measures as a way to reduce costs. Cost reduction is an important priority for all of the automakers. For example, Ford requires a 5% price reduction per year as a condition for suppliers to receive a multi-year contract. Chrysler also provides incentives for suppliers to make cost-reducing suggestions through its SCORE program. Since pollution prevention is a relatively unexplored area, it has the potential to yield larger savings than do such traditional techniques as looking for labor savings, techniques which firms have already applied many times.

### 3. Among firms in the supply chain as a whole

a. coordinate work with suppliers to a single customer

Perhaps CAMP could work with the plant manager of a nearby plant about a coordinated program of improvement. The plant manager could refer suppliers to CAMP for help with their internal waste reduction. Conversely, CAMP could serve as a go-between for suppliers. Many suppliers felt hesitant about approaching major customers with ideas for waste prevention, or felt unable to consider long-term investments in waste reduction because of uncertainty about the nature and amount of future orders they might receive. CAMP might be able to raise such issues of coordination across the supply chain in a neutral manner.

b. help firms in the Northeast Ohio auto supply chain to see their common interests

As discussed in chapter VII, Northeast Ohio firms have an unrealized advantage, in that their proximity to each other facilitates face-to-face discussion. CAMP already sponsors events where automotive suppliers could meet each other and learn about common problems and their solutions. In addition, CAMP might convene an advisory board which would sponsor a local version of Japan's Deming award. This award is given annually to a firm which has demonstrated exemplary performance in the area of quality; competing for the award has served as an important spur to firms' efforts in this area.<sup>31</sup>

---

<sup>31</sup> See Michael Cusumano, *The Japanese Automobile Industry*. Cambridge: Harvard University Press, 1986 for a discussion of how competing for the Deming award led both Nissan and Toyota to greatly improved performance.

## APPENDICES

### Appendix A -- Types of Waste and Current Reduction Activities

Of the data set of 28 northeast Ohio automotive suppliers, the following types of waste are produced.

SOLID		LIQUID	
Garbage/rejects	6	Oils/Coolants	1 2
Broken pallets	2	Sludge; base metals	9
Corrugated boxes	2	Chemicals/solvents	9
Bags (chems/clay)	1	* from cleaning	2
Scrap metal; flash	15	* from prod. process	2
Scrim/Rubber	2		
Plastic/teflon	2	AIR	
Barrels (metal)	1	Emissions	6
TIME (poor layout)	3	None mentioned	1

#### Current waste reduction activities

Of the data set of 28 northeast Ohio automotive suppliers, the following indicates the types of current waste reduction activities carried out. NOTE: Some interviewees did not answer fully, so these are minimum numbers for the companies interviewed.

	Total	% (set of 28)	% (of 22; not "outsources")
Sell scrap metal	13	46%	59%
Redesign process to reduce waste	4	14%	18%
Recycle or reclaim wastes	11	39%	50%
Air emissions treatment	6	21%	27%
On-site water treatment	7	25%	32%
Switch to aqueous systems	2	7%	9%
Returnable packaging	5	18%	23%
No/little information	6	21%	--

## Appendix B – Environmental Liability

This chart shows the distribution of companies whose environmental liability is small, medium and large. Companies that produce hazardous waste are defined as having large liability, unless the amount the produce is very small, in which case they were judged as having medium liability. Small liability companies produce only inert wastes.

	Number	Percent
Small/Nothing hazardous	13	39%
Medium	8	24%
High/Hazardous materials	7	21%

Two other statistics relate to liability. First, two of the companies (or, 6%) are engaged in major site remediation projects. In both cases, the environmental damage was caused companies that previously occupied the same site. Second, 6 of the companies in the data set are what the study terms “outsourtees.” That is, they are companies to which other companies outsource processes, recycling, or disposal. Five of these six companies have high liability, which suggests that a major motivation companies to outsource is to transfer responsibility for environmental liability into other hands.

### Appendix C – Certifications

The following charts identify the numbers of the companies in the data set that have or are working towards the QS9000 certification as well as those that are working towards or aware of the upcoming ISO14000 certification.

	have QS/ ISO9000	going for 9000	don't know
Totals:	6	18	5
Percents:	20%	60%	17%
	aware of ISO14000	going for ISO14000	not mention 14000/no info.
Totals:	7	1	22
Percents:	23%	3%	73%

[One company in the data set claims that they would qualify for QS9000 now, but that they chose not to participate due to the cost of the program. They are excluded from the top chart.]



## Appendix D - Case Study of Pollution Minimization in the Metal Finishing Industry

### Industry and Process Overview

#### Industry and Process Overview

According to the National Association of Metal Finishers (NAMF), the American surface finishing industry employs about 100,000 people in over 3000 job shops. Annual sales are over \$4 billion. Automotive parts make up the largest market segment, followed by consumer durables and defense. A typical shop employs 15 to 20 people, is capitalized at about \$400,000 and takes in \$800,000 in gross annual revenue.<sup>32</sup> Although many manufacturers perform surface finishing in their own facilities, NAMF notes that "there is a growing trend to subcontract" surface finishing for three reasons: (1) the high capital and operating costs of a finishing facility, especially when not used at full capacity; (2) costly health, safety, and environmental regulations; and (3) high energy costs to run a finishing facility.<sup>33</sup>

Judy Kish, Executive Secretary of the Ohio Association of Metal Finishers, stated that there were some 175 to 200 metal finishers in northern Ohio, including the Toledo, Sandusky, and Youngstown areas, but that most of these were located in Cleveland-Akron-Canton. She felt that this area was about fourth or fifth in geographic concentration, with southern California, Chicago, Philadelphia-New Jersey-New York, and Detroit ahead of this region.<sup>34</sup>

The Freedomia Group, Inc., a Cleveland market research firm, anticipates that US demand for corrosion inhibitors will increase about 5.6% per year through 2000. Automobile parts will "present attractive growth opportunities" as consumers continue to demand longer lasting vehicles and manufacturers seek to reduce buyer warranty claims. Environmentally compliant coatings will "continue to gain favor over those based on hazardous chemicals" such as heavy metals (especially chromium).<sup>35</sup> Another market survey found that sales revenue increased between 1993 and 1994, as did the number of plating facilities, but that total employment declined 22%. This probably indicates that the industry is becoming more capital-intensive; platers are automating processes wherever possible. Job shops reported that between 1993 and 1994 percentage costs for Labor and Safety and Health were "higher," while percentage costs for Material and Environmental were "much higher."<sup>36</sup>

Surface finishing consists of two major types of processes, plating and coating. Plating usually refers to electroplating (although other electroless forms, like mechanical zinc plating, exist) and is done to improve corrosion resistance and appearance. This process deposits a metallic coating onto a work piece by immersing it into a plating solution. A low-

---

<sup>32</sup> A study of the industry conducted for CAMP by the Waste Reduction Institute for Training and Research (WRITAR) drew on the US Department of Commerce's 1992 Census of Manufacturers. This study found similar number of shops and average employee per shop. However, its estimate of industry sales was much higher (\$10 billion in 1992), leading to a significantly higher estimate of sales per shop. See WRITAR, "Profile of the Metal Finishing Industry", Minneapolis, April 1995.

<sup>33</sup> National Association of Metal Finishers, "Understanding Surface Finishing," n.d.

<sup>34</sup> Telephone conversation between Judy Kish and David Hochfelder, July 25, 1996.

<sup>35</sup> "US Demand for Corrosion Inhibitors on the Rise," *Finishing Line* (NAMF newsletter) 18:2, April/May 1996, p. 7.

<sup>36</sup> Surface Finishing Market Research Board, "Metal Finishing Industry Market Survey, 1993-1994," pp. 3-4.

voltage current causes the metallic ions in the plating solution to migrate and attach to the work piece. The auto parts industry uses chromium and zinc coatings for corrosion resistance. Chromium provides the best corrosion protection and appearance, but poses health, safety, and environmental issues. Zinc is commonly used for corrosion protection on fasteners, stampings, and sheet metal parts. Hard chromium and cadmium are also used.

The typical electroplating sequence consists of three basic steps, with a rinse step after each. Incoming work is first immersed in an alkaline cleaning solution to remove dirt, oil, and rust. Second, parts are immersed in a mild acid bath to neutralize any remaining traces of the alkaline cleaner. Finally, the work is placed in the plating solution where it is coated.

Coating refers to the deposition of paint onto a part for corrosion protection and appearance. There are four major coating techniques: (1) dip coating, the immersion of parts into a tank of paint; (2) flow coating, "pouring" paint over the work piece; (3) spraying; (4) and powder coating, a new technique which places paint particles onto the work piece. The last method uses no volatile organic compound (VOC) based thinners and excess powder may be easily collected and reused.

The coating process consists of three major steps. The work is first prepared for coating to ensure a clean, dry, and smooth surface. The coating is then applied, using one of the four methods discussed above. Finally, the part is cured to obtain good bonding of paint to surface. Curing is typically done in ovens.

### **Regulatory Climate**

The processes used in plating and surface finishing pose major health, safety, and environmental issues. Further, the USEPA and OSHA have tightened emission and exposure limits for heavy metals, hexavalents (chrome), and solvents. Since the industry is made up of relatively small firms, both compliance and pollution prevention may be costly for these firms. The industry's three major trade associations (National Association of Metal Finishers, American Electroplaters and Surface Finishers Society, and the Metal Finishing Suppliers Association) are aware of this burden and have taken several courses of action. (1) They have formed government contact groups to work more closely with regulatory bodies. These government relations programs also challenge new regulations, seeking to roll back more stringent limits or to defer compliance. The Joint Government Relations Program of the NAMF, AESF, and MFSA estimated that the EPA's deferral of Clean Air Act Title V compliance for chrome platers avoided costs of \$25,000 per facility and \$25 million for the total industry. They are also actively opposing stricter Permissible Exposure Limits (PELs) on the amount of chromium workers are exposed to. (2) The industry provides outlets for information and technical assistance, such as the National Metals Finishing Resource Center and various Websites. (3) Several partnerships with the USEPA Environmental Technologies Initiative, the Department of Energy, and Lawrence Livermore National Laboratory seek to develop zero-discharge technologies for the metal finishing industry.

NAMF stresses that the industry has "a serious concern for environmental considerations," and that it works "in a cooperative manner" with the USEPA and other regulatory agencies. The industry, both individual firms and trade associations like the NAMF, seeks to minimize and eliminate waste where possible. NAMF claims that "the

surface finishing industry is now one of the most environmentally protective of any industrial group in America.”<sup>37</sup>

Although emission and exposure limits have become more strict, the regulatory stance of the USEPA and state agencies has shifted in recent years from an emphasis on compliance to a process-oriented outlook to reduce waste. This has taken several forms. The USEPA and state agencies provide pollution prevention suggestions and technical information to platers and surface finishers. Some states provide compliance assistance and waiving of penalties to firms under 100 employees. The USEPA is also moving toward self-policing, based on due diligence, disclosure, and correction. Firms that voluntarily disclose and quickly correct noncompliances will have penalties reduced by 75% to 100%. According to Greg Waldrip of the EPA Office of Enforcement and Compliance Assurance, the EPA is considering whether firms with ISO 14000 certification even “need our oversight;” perhaps they will no longer “fall within EPA’s command and control structure.”<sup>38</sup>

### Major Health and Environmental Issues

Typical wastes generated in the metal finishing industry are: wastewater sludge, spent plating and stripping bath solutions, spent process batch solutions, spent acid and alkaline cleaners, waste solvents and oils, and metal chips and dust from prior metalworking steps. Plating and stripping solutions and acid and alkaline cleaners may pose health issues, while all these byproducts are candidates for pollution prevention.

*OSHA and Stricter PELs.* In the fall of 1996 the US Occupational Safety and Health Administration is planning to tighten workers’ exposure limits on 428 toxic chemicals, including cutting oils, metal dust, and welding fumes. Unions like the UAW and the Oil, Chemical, and Atomic Workers are actively supporting OSHA’s plans. UAW, for instance, seeks to lower the current exposure limit on oil mists from 5 mg/m<sup>3</sup> to 0.5 mg/m<sup>3</sup>. The Big 3 supports this initiative as well.<sup>39</sup>

OSHA is also tightening the PEL for hexavalent chrome, from present levels of 100 mg/m<sup>3</sup> to 1.0 mg/m<sup>3</sup>. USEPA is also moving toward stricter emission requirements for chromium. Of the state regulatory bodies, California has the strictest limits, requiring airborne removal efficiencies of at least 99.8%. These moves may affect up to 5000 platers.<sup>40</sup> Since chrome plating is one of the most common corrosion inhibitors for auto parts, compliance will prove costly to smaller job shops. Chrome is also the best anti-corrosion coating; an industry advocate noted, “Substitutes with equal or better performance may not be available, or will require long periods of development and analysis.”<sup>41</sup>

*Compliance versus Pollution Prevention.* Compliance is adherence to regulatory emission and exposure limits, and is traditionally accomplished through “end-of-pipe” treatment such as smokestack scrubbers and sludge disposal. Pollution prevention is a process improvement falling into one of three categories. The best way to prevent pollution is Source Reduction,

---

<sup>37</sup> “Understanding Surface Finishing.”

<sup>38</sup> “A Kinder, Gentler EPA?” *Manufacturing Engineering*, May 1996, p. 14.

<sup>39</sup> James R. Koelsch, “Launder Your Dirty Air,” *Manufacturing Engineering*, May 1996, p. 41.

<sup>40</sup> KCH Services Inc., “Controlling Chromium Emissions,” Forest City, NC, n.d.

<sup>41</sup> Frank Altmayer, AESF Technical Director, “Hexavalent Chromium PEL,” *Plating and Surface Finishing*, June 1996, p. 36.

which eliminates or replaces chemicals or processes which generate waste. In situations where this cannot be done, Waste Minimization, or the conservation of materials which are the source of pollution, is the best alternative. Four general methods of Waste Minimization are: inventory management, production process modification, volume reduction, and resource recovery. The last pollution prevention method is On-site Recycling, or the reuse of materials which are the source of pollution. Pollution prevention does not include: off-site recycling, waste treatment, or disposal.

*Sludge Generation.* CAMP has estimated that as little as 15% of the metal added to a plating tank will end up on the plated parts. In other words, 85% of the purchased metal will appear in the wastewater and sludge. This is principally due to "dragout," or the migration of process bath solution into rinse tanks, usually because some solution adheres to parts when they are moved between tanks. Dragout results in three costs: higher water usage and sewer fees, increased wastewater treatment expense, and wastage of metal salts.

*Rinse Water Usage.* The rinse system consumes about 90% of the water used in a plating shop. Fresh water must be added constantly due to contamination from dragout. High flow rates not only result in higher sewer rates but also indicate extensive dragout. Several methods exist to reduce water flow rates, including counterflow and cascade rinsing.

### **Cleveland Platers Which CAMP Has Worked With**

CAMP has researched waste minimization at four local surface finishing firms, which we will call firms 1, 2, 3 and 4.<sup>42</sup>

*Firm 1.* Practice at this firm before the CAMP study was to treat wastewater to destroy cyanide, reduce hexavalent chromium to trivalent chromium, then to precipitate out these substances as sludge, and to flush the resultant wastewater into the sewer. This firm spent \$13,611 on water/sewer service and \$43,168 on wastewater treatment (total of \$56,779) per year. This firm sought CAMP assistance to reduce both these costs. CAMP hit upon two methods: to reduce the usage of water and to reduce the toxicity of wastewater. CAMP investigated two ways to reach these goals. The first was to reduce dragout, a solution which involves little capital expenditure but some changes to the process. Means to do this include: installing drip trays between the process and rinse tanks, lengthening drain times over the process tank, and installing spray rinses over the process tank. The second approach was to install a closed-loop system which recovers process metals and recirculates rinse water. Installation of a closed-loop system is essential to becoming a "zero-discharge" plating shop. CAMP identified and priced out equipment from Kinetico of Newbury, Ohio; a closed loop system costs from \$15,000 to \$80,000 depending on flow rate. Potential cost savings from such a system: savings in recovered process metal, about \$40,000; and savings in sewer and wastewater treatment fees, about \$50,000; total about \$90,000.

*Firm 2.* This firm suffered from high nickel content in the wastewater, a situation which CAMP felt had to "be brought under control promptly to assure continued operation of the facility." CAMP recommended that this plater investigate installation of a closed-loop system from Kinetico to reduce costs and to ensure regulatory compliance. In conjunction, CAMP sought to cut water usage by reducing dragout.

---

<sup>42</sup> Information about these four firms is contained in the Erieview folder which Amy Whitehead loaned to Dave Hochfelder, currently in his possession.

*Firm 3.* The CAMP investigators felt that “a few simple changes to the rinsing procedures, and some piping changes” would both reduce water flow rate and lower the toxicity of wastewater. This would “substantially reduce the amount of sludge sent to a hazardous waste landfill” and would result in lower waste disposal and treatment costs, reduced process metal purchases, and lessened regulatory liability.

The recommended method to reduce water usage was to repipe the rinse tanks for counterflow rinsing, a method in which fresh water enters the rinse system at the greatest distance from the point of part entry and is successively transferred to the rinse station next nearest to the point of part entry. Counterflowing three rinse tanks reduces water flow rate by 95%. Other methods include flow restrictors, fog spray rinses, and conductivity controllers. The last adds water only when the rinse tank conductivity rises, indicating contamination.

CAMP recommended dragout reduction as the best means to reduce wastewater toxicity. Four methods exist here: slower withdrawal from finishing baths, increased hang times about process tanks, still rinsing immediately after plating bath, and improved racking orientation. The last has the greatest effect upon dragout, especially due to blind holes which face upward. Angling them downward allows them to drain.

The investigators thought that implementation of both these solutions, countercurrent rinsing and reduced dragout, would lower purchases of plating chemicals by 50% and would reduce sludge treatment and disposal costs by 50%. Based on these figures, CAMP calculated a payback of about six to seven months.

*Firm 4.* This firm has a 50,000 square foot facility providing phosphatizing, pickling, zinc and cadmium plating, and anti-corrosion coating. It employs about 65 people and does \$5 to \$10 million in annual sales. The president sought CAMP’s assistance to become a zero-discharge facility. CAMP noted that “this may or may not be possible.”

### **Case Studies from Vendors and the Trade Press**

Some chrome platers are adopting a “zero-discharge” philosophy for hexavalent chrome, seeking not only to comply with the most recent OSHA and EPA limits, but also to stay ahead of future tightened requirements. One Canadian chrome plater, Court Industries in St. Catherines, Ontario, found it necessary to build a new facility to achieve zero-discharge. The plant’s general manager found that “the goal of risk minimization necessitated...the use of State-of-the-art building and equipment considerations and the best available technology.”<sup>43</sup> While building a new facility and installing new equipment is simply not feasible for most platers, the strategy of Court Industries may be appropriate for firms just starting in the chrome plating business or platers replacing outdated equipment.

Other platers have met exposure and stack limits through less drastic means, such as retrofitting an existing plating line with closed-loop filtering and reclamation systems. These may be fitted into existing equipment piecemeal, with minimal disruption to production. Retrofitting at Hill Air Force Base in Utah took 7 to 10 days to install each of ten mist eliminators. Ultra Plating Corp. of Green Bay, WI installed scrubbers which completely covered the chrome process baths to collect and reclaim the fumes. Midwest Air Products Co., maker of the scrubber, claimed not only that this system meets “the most stringent

---

<sup>43</sup> KCH Services Inc., p. 17.

hexavalent chrome emission requirements,” but also that the system paid itself back “in months, not years” because it reclaimed and reused chrome.<sup>44</sup>

Eastside Plating in Portland, Oregon moved to zero-discharge in the late 1980s, estimating that this saved them about \$300,000 annually. The firm implemented these changes in a series of steps. First, it converted its rinse system to counterflow and cascade rinsing systems, a move which reduced water use significantly and brought them into regulatory compliance. Eastside then searched for waste treatment chemicals which decreased, instead of increased, sludge production. Changing reducing agents cut their chromium and cyanide wastes in half. The plater felt that equipment and chemical vendors were more than willing to provide engineering assistance as a means to demonstrate their products.<sup>45</sup>

---

<sup>44</sup> Midwest Air Products Co., Inc., “MAPCO Case History” for Hill Air Force Base and Ultra Plating.

<sup>45</sup> “The Eastside Plating Success Story,” EnviroSenSe Web Page, <http://es.inel.gov/techinfo/facts/eastside.html>.