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**Issues, challenges, and changes faced by purchasing professionals
during the implementation of packaging solid waste reduction
efforts**

Farris, Martin Theodore, II, Ph.D.

The Ohio State University, 1994

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**ISSUES, CHALLENGES, AND CHANGES FACED BY PURCHASING
PROFESSIONALS DURING THE IMPLEMENTATION OF
PACKAGING SOLID WASTE REDUCTION EFFORTS**

DISSERTATION

**Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University**

By

Martin Theodore Farris II, B.S., M.B.A., M.A.B.A

*** * * * ***

The Ohio State University

1994

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*Ideals are like stars:
You will not succeed in touching them with your hands,
but like the seafaring man on the desert of waters,
you choose them as your guides,
and following them,
you reach your destiny.*

Anonymous

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I would like to dedicate this to two of the finest people I have ever known; my father, Dr. Martin T. Farris, scholar, teacher, and parent extraordinary, who inspired me to pursue academia, and my late mother, Rhoda Farris. Their love and guidance will always provide inspiration for me.

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TABLE OF CONTENTS

ACKNOWLEDGMENT	iii
VITA	iv
TABLE OF CONTENTS	vi
LIST OF TABLES	xiii
LIST OF FIGURES.....	xvii
CHAPTER	
I. INTRODUCTION	1
Background.....	1
Statement of Problem	3
Scope	6
Methodology	8
Stage One - Survey.....	8
Stage Two - Case Study	9
Assumptions and Limitations.....	10
Potential Contributions of this Study.....	11
Organization of this Study	14

II. REVIEW OF THE LITERATURE	16
Introduction	16
Background	17
The Modern Environmental Movement	17
The Growing Solid Waste Problem	20
Landfill Limitations	22
Introducing Legislative Action.....	26
Federal and State Governments	26
Environmental Protection Agency.....	30
Federal Trade Commission.....	31
City and Local Governments	31
Increasing Legislative Focus.....	32
Threat of Legislation	33
The International Environmental Scene.....	33
Germany	34
Italy.....	36
Switzerland	36
The Netherlands and France	36
Canada	36
Packaging Material: The Largest Component of the Solid Waste Stream	37
Advantages of Corporate Solid Waste Management.....	42
Recycling Items From the Corporate Solid Waste Stream.....	48
Reusable Containers.....	49
Creating a Corporate Environmental Policy	50
Corporate Examples of Solid Waste Reduction Efforts	52
Summary.....	54

Linking Purchasing Operations to Corporate	
Solid Waste Reduction Efforts.....	54
Introduction.....	54
Evolution of Purchasing.....	55
Purchasing's Role in Implementing Solid	
Waste Reduction Policy	58
Changing Skill Requirements.....	59
Summary	62
Present Environmental Involvement of Purchasing.....	62
Packaging Redesign	64
Summary	65
Conclusion	66

III. RESEARCH DESIGN..... 68

Introduction.....	68
Research Hypotheses	69
Methodology.....	80
Stage One: Survey.....	80
Survey Design and Pre-Test	80
Survey Group	83
Survey Procedure	89
Sample Selection.....	93
Hypothesis Testing.....	95
Data Entry.....	117
Desired Sample Size.....	118
Stage Two: Case Study	120
Case Study Scenario A.....	121
Case Study Scenario B	121
Case Study Scenario C.....	123
Direct Funding	127
Summary	127

IV.	DATA FINDINGS AND ANALYSIS.....	129
	Introduction.....	129
	Stage One: Mail Survey.....	129
	Survey Pre-Calling	130
	Survey Response Details	138
	Respondent Demographics	143
	Differences in Solid Waste	
	Management Effort.....	144
	Details of Solid Waste	
	Management Efforts	145
	Likert Scale.....	147
	Respondent Tenure in Current Position.....	149
	Hypothesis 1.1	150
	Hypothesis 1.2	152
	Hypothesis 1.3	152
	Hypothesis 1.4	154
	Hypothesis 1.5	156
	Hypothesis 2.1	157
	Hypothesis 2.2	158
	Hypothesis 2.3	160
	Hypothesis 2.4	161
	Hypotheses 3.1, 3.2, 3.3, 3.4,	
	4.1, 4.2, 4.3, and 4.4	163
	Hypothesis 3.5	165
	Hypothesis 3.6	166
	Hypothesis 4.5	169
	Hypothesis 4.6	172
	Trends.....	174
	Other Findings.....	179
	Summary of Mail Survey Results.....	180

Stage Two: Case Studies	191
Solid Waste Motivations	193
Purchasing Operations	197
Setting Reduction Goals	198
Involvement in the Supply Chain	202
Purchasing Involvement	207
Purchasing Skills	208
Organizational Changes	213
Involvement with Customers	214
Measuring Reduction Efforts	215
Sourcing Complexity	219
Reduction Efforts	221
Business Cases	226
Differences From Other Companies or Industries	228
What Companies Would Have Done Differently	230
Summary of Case Studies	232
Summary	234
V. CONCLUSIONS	235
Introduction	235
Summary of Research	235
Research Conclusions	237
General	237
Motivation	238
Alternatives	239
Goals and Measurement	239
Sharing Efforts with Suppliers	240
Organizational Changes	241

Skill Requirements	241
Reusable Packaging.....	242
Influence on the "Buy" Decision.....	242
Differences in the Type of Packaging	
Material Used.....	243
Differences in Packaging Characteristics	244
Time to Make a Sourcing Decision.....	245
Complexity of Sourcing Decision	245
Involving Adjoining Members of the	
Supply Chain.....	246
Customer and Supplier Relationships	247
Other Conclusions from the Case Studies	248
Research Methodology Conclusions.....	253
Pre-Calling Effectiveness.....	253
Timing When to Conduct Research	254
Mail Room Turnaround	254
Use of Phonemail Technology	254
Case Study Fallout Rate	255
Summary	256
Implications.....	256
Characteristics of a Best Practice Company.....	263
Future Research	265
Expanding the Scope	266
Addressing All Waste Reduction Efforts	266
CEO Perspective	267
International Perspective	267
Investigate the Retail Industry	267
Longitudinal Study of Corporate Solid	
Waste Awareness.....	268
Investigate a Complete Supply Chain	268
Explore Reduce, Reuse, and Recycle	269

Probing Closer	270
Lessons From the Food Industry.....	270
Development of Effectiveness Scale.....	270
Identify Proper Measurements.....	271
Summary.....	272
Summary	273

APPENDICES

A. Glossary of Terms.....	277
B. Survey Documentation	282
C. Statistical Analysis of Survey Responses.....	290
D. Interview Protocol.....	327
E. Case Studies.....	331
BIBLIOGRAPHY	374

LIST OF TABLES

Table		Page
1	Remaining Years of Landfill Capacity in the 48 Contiguous States	23
2	State Recycling Goals and Deadlines.....	29
3	Recyclable Materials in Commercial Waste.....	39
4	Products in the Municipal Waste Stream	40
5	Management of Waste and Recycling.....	45
6	Opinions About Solid Waste Management and Recycling.....	46
7	Specific Actions Related to Solid Waste Management: Grocery CEO Survey Results	47
8	Purchasing Evolution.....	56
9	Primary Research Questions.....	70
10	Research Question 1	71
11	Research Question 2	72
12	Research Question 3.....	74
13	Research Question 4.....	75

Table	Page
14	The Top 100 Domestic Consumers of Packaging Material and Containers.....86-88
15	Cross-Reference of Hypotheses H1.1 through H1.5 and Questionnaire Items 98
16	Cross-Reference of Hypotheses H2.1 through H2.4 and Questionnaire Items 99
17	Cross-Reference of Hypotheses H3.1 through H3.6 and Questionnaire Items 100
18	Cross-Reference of Hypotheses H4.1 through H4.6 and Questionnaire Items 101
19	Sample of Computer Database Variables..... 134
20	Mail Survey Response Rate..... 137
21	Campus Mail Services Turnaround..... 142
22	Summary of ANOVA Analysis for Questions 1 Through 12 147
23	Summary of Hypothesis Acceptance or Rejection.....187-190
24	Motivations To Manage Solid Waste..... 196

Table	Page
25	Centralization/Decentralization of Sourcing/Buying Activities 199
26	How Companies Set Solid Waste Reduction Goals 200
27	Involvement of Suppliers and Customers in Solid Waste Reduction Efforts..... 205
28	Purchasing Involvement in Solid Waste Reduction Efforts 206
29	Purchasing Skills Needed To Support Solid Waste Reduction Efforts..... 210
30	How Purchasing Supports Solid Waste Reduction Efforts 213
31	How Purchasing Is Involved With Customers 214
32	How Solid Waste Reduction Efforts Are Measured..... 217
33	How Sourcing Complexity Has Changed..... 218
34	Corporate Solid Waste Reduction Efforts 225

Table	Page	
35	Formality of Solid Waste Management Business Cases.....	229
36	What Companies Would Have Done Differently To Manage Solid Waste	232
37	Summary of Acceptance/Rejection of Hypothesis H_{1.1} through H_{1.5}	249
38	Summary of Acceptance/Rejection of Hypothesis H_{2.1} through H_{2.4}	250
39	Summary of Acceptance/Rejection of Hypothesis H_{3.1} through H_{3.6}	251
40	Summary of Acceptance/Rejection of Hypothesis H_{4.1} through H_{4.6}	252

LIST OF FIGURES

Figure		Page
1	Historical Municipal Waste Stream - Weight.....	21
2	Average Landfill Tipping Fees in the U.S.	24
3	Average Tipping Fees by Region of the U.S in 1992.	25
4	Typical Waste Content of a Landfill by Volume in 1988.....	41
5	Simplified Sourcing and Routine Purchasing Process.....	76
6	Top 100 Purchasers of Packaging Material in 1991.....	85
7	Survey Research Process.....	90
8	Case Study Scenarios in the Supply Chain.....	122
9	Case Study Research Process.....	125
10	Time Required for Survey Responses.....	140
11	Cumulative Time Required for Survey Response.....	141
12	Increased Supply and Static Demand Reduces Commodity Prices.....	258

CHAPTER I INTRODUCTION

Background

Since the early 1960s, the modern environmental movement has gained the advantage of a global perspective and technological advancements to further address how environmental concerns impact corporate policy. Actions by private enterprise suggest increasing corporate environmental awareness and efforts to reduce consumer and industrial solid waste.

The largest component of solid waste, both consumer and industrial, is packaging material. The study concentrated on how corporate environmental action for reducing the amount of packaging material in the solid waste stream has and will affect the corporate purchasing function. Corporate actions to reduce the amount of packaging material entering the solid waste stream may include:

- 1. Reducing the amount of packaging material on purchased products coming into the corporation from suppliers;**
- 2. Reducing the amount of finished goods packaging on products shipped to customers;**
- 3. Reducing the amount of other materials deposited into the waste stream.**

Corporate purchasing activities are likely to be affected by corporate solid waste reduction efforts. The purchasing function is responsible for working with vendors to supply the needs of the company. Packaging material is used by suppliers to protect, store, and facilitate handling of their products. Packaging material used by suppliers may include three types of packaging:

- 1. Primary packaging containing the finished product, such as a can or bottle of a beverage.**
- 2. Secondary packaging to facilitate transportation or user convenience by consolidating primary packaging units, such as a six-pack container.**
- 3. Tertiary packaging to facilitate transportation or user convenience by consolidating secondary packaging units, such as a beverage case or pallet.**

Unless a reverse logistics channel exists between the customer and supplier to facilitate the return of packaging material, the material will enter the waste stream of the receiving company. The purchasing organization supports the corporate solid waste reduction effort by acting as a gatekeeper, working to reduce or avoid receiving packaging material that will ultimately enter the company's solid waste stream and provide insight into the reduction of outbound packaging material. The purpose of this research was to identify and analyze how the corporate purchasing function has changed as a result of corporate actions to reduce the solid waste stream.

Statement of the Problem

The maturation of corporate environmental awareness may change the day-to-day activities of the corporate purchasing function. The changes to the corporate purchasing function may include:

1. Heightened awareness or exposure to upper management;
2. Changing skill requirements for buyers;
3. Modified sourcing or buy decisions;
4. Modified supplier-customer relationships.

The following research questions were addressed in this study:

Research Question 1:

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation within the company?

Research Question 2:

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation within the company?

Research Question 3:

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation throughout the supply chain?

Research Question 4:

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation throughout the supply chain?

Increases in industrial and commercial recycling and the increase in the number of green marketing campaigns suggest an increase in environmental awareness by corporations. Corporate activities suggest environmental awareness has permeated the corporate plan, yet little has been written about how the increasing awareness has affected purchasing operations.

Purchasing is faced with internal and external environmental influences. Internal influences may include formal or informal solid waste management policy guiding the purchasing actions or performance measurements.

Purchasing plays a key role as the gatekeeper of the corporation in avoiding or reducing the amount of packaging material that ultimately enters the solid waste stream of a company. Supporting corporate solid waste reduction efforts may result in modifications to how purchasing operates; perhaps requiring additional or unique purchasing skills, a modified organizational structure, or additions to the functional relationships between purchasing and other functional groups in the corporation. The purpose of research questions number 1 and number 2 was to investigate how corporate purchasing practices, specifically with respect to packaging materials, have changed and will change, in response to efforts to reduce solid waste generation within the company.

External influences may include green marketing techniques or environmental policies of suppliers directed toward the purchasing organization. One of the roles of purchasing is to operate as the interface between company requester and the supplier. Corporate solid waste management efforts may modify relationships between customer and supplier, as new requirements arise or current requirements are modified to incorporate solid waste reduction efforts. Changes may include requirements for reduced use of secondary and tertiary packaging material or the use of reusable containers. The purpose of research questions number 3 and number 4 was to investigate how corporate purchasing practices, specifically

with respect to packaging materials, have changed and will change, in response to efforts to reduce solid waste generation throughout the supply chain.

Scope

The research examined how business approaches the environmental problems associated with the use of packaging materials and how purchasing operations have been modified in response to these efforts.

The research encompassed the theoretical framework that best practice companies adapt to external forces. The research design centered around understanding what the current best practice is and sought to determine the projected affect corporate solid waste reduction efforts would have on the purchasing function over the next three years.

The research design studied the industries which are the top consumers of packaging material in the United States. The top three industries represent over sixty percent of the total packaging tonnage purchased each year.

The study surveyed purchasing executives who are members of the National Association of Purchasing Management. The National Association of Purchasing Management is a professional organization promoting the advancement of the purchasing field and has provided a grant to help support this research.

Survey and case study of purchasing executives working for the top users of packaging material offered insights to how firms with best practice purchasing organizations are addressing corporate solid waste management.

The term "purchasing" was used throughout this study to indicate the activities that take place during business-to-business purchasing in industrial manufacturing companies. The research examined only business-to-business purchasing. Consumer purchasing, often associated with consumer behavior, was not be a part of this study. Appendix One contains a glossary of terms to assist the reader in understanding the specialized terminology found in this study.

Corporate environmental awareness may include specialized handling of hazardous materials, abatement of emissions of air or water pollutants, or reduction of liquid or solid waste stream. The terms "environmental policy," "environmental awareness," and "solid waste management" were used throughout this research to indicate the written or unwritten directives, actions, decisions, and goals embraced by a company to reduce the amount of packaging material entering the solid waste stream. The research was focused on industries that use large amounts of packaging material.

The term "buy decision" was used throughout this research to indicate the activities between the company purchasing organization and its suppliers. These activities include "the selection of supply source locations, determination of the form in which the material is to be acquired,

timing of purchases, price determination, quality control, and many other activities."¹

Methodology

The research involved a two stage methodology. It combined a questionnaire survey to determine how corporate solid waste reduction of packaging material affects purchasing with qualitative case studies to examine successful programs for implementing and maintaining solid waste management efforts.

Stage One - Survey

The research data was collected through a mail questionnaire of industries that tend to use large amounts of packaging materials. Questionnaires were sent to the highest ranking purchasing executive in the company. Survey contact names were obtained from the Center for Advanced Purchasing Studies, an affiliate of the National Association of Purchasing Management.

The research instrument was pre-tested through faculty review and personal industry interviews for content validity, ease of understanding of the content, and willingness and ability of the executives to respond to the questions.

¹*Strategic Logistics Management*, Stock, James R. and Douglas M. Lambert, Second Edition, 1987, Richard D. Irwin, p. 18.

Prospective respondents received a pre-notification letter and were contacted by telephone to request their cooperation. A cover letter from NAPM was included with the survey. The survey was sent only to those individuals who had agreed to respond.

Stage Two - Case Study

The second stage involved the use of case studies to examine approaches to the implementation and maintenance of solid waste management efforts of packaging material within case study companies and throughout the supply chain. The case studies started with the survey questions and utilized follow-on questions to further probe and understand the influence of corporate solid waste management efforts on the corporate purchasing function. Participants in the case studies were identified from the surveys during the first stage. Seven case studies were conducted to examine the following situations:

1. Respondent company works with supplier to reduce incoming primary, secondary, and tertiary packaging material.
2. Respondent company reduces primary, secondary, and tertiary packaging material used internally through alternative packaging, reusable containers, and challenging the need for packaging.
3. Respondent company reduces the amount of outgoing primary, secondary, and tertiary packaging material used to meet the request of customers.

A more detailed description of the case study methodology is contained in Chapter Three.

Assumptions and Limitations

There are a number of assumptions and limitations that warrant treating the results of this research with proper care. These assumptions and limitations include:

1. **Type of Research** - The nature of this research was exploratory and descriptive. Conclusions are arrived at primarily by inductive reasoning, rather than by clear establishment of causality. The survey data was subject to the personal biases of the individual responding and may not correctly reflect the true cause of action.
2. **Membership Surveyed** - The membership of the National Association of Purchasing Management was surveyed. It is assumed the mean responses to the surveys are an accurate representation of what the mean response would be if all companies in the industry participated in the survey.
3. The survey data was subject to the bias and environmental awareness of the individual surveyed. The professional organization may directly or indirectly influence the professional through professional meetings or publications.

4. **Generalization of the Sample -** The research was intentionally limited in scope to permit detailed analysis of each industry. The investigation of the top three industries by packaging tonnage represents over sixty percent of the total packaging tonnage purchased each year. The results are applicable only to the industries studied and not to industry generally. It is possible the industries studied are influenced by situational pressures. A chemical company may aggressively address solid waste reduction in part to appease and offset overall pressures by environmental special interest groups.
5. **Overaggregation of Packaging -** There are many different forms of packaging. The research did not distinguish between the different types of packaging either by form, function, reusability, or commodity type. The research addressed the volume and the weight of the packaging material as the primary factor considered in solid waste reduction efforts.
6. **Hazardous Materials Excluded from Research -** The scope of the study intentionally excluded the management of hazardous materials. The reduction and disposal of hazardous materials often is a specialized effort which could potentially complicate the research.

Potential Contributions of this Study

The research provides a number of contributions to understanding the implications of the management of packaging waste for purchasing from an internal and external perspective. Little is known about how purchasing organizations approach the integration of solid waste reduction efforts into daily operations. In his white paper "Reverse Logistics"² Stock states that "little published material has examined the logistics activities associated with source reduction, recycling, substitution and/or waste disposal...much must be inferred about reverse logistics from the vast quantity of books, articles and other documents that have been written on environmental policy and practice since the material does not specifically examine reverse logistics issues."

The research offers insight into industrial practice and theory in five areas:

1. Solid waste effort design;
2. Understanding changes to the "buy" decision;
3. Changing roles and responsibilities of purchasing;
4. Changing relationships between customers and suppliers;
5. Lessons learned from successful industry practice.

²"Reverse Logistics," a white paper prepared for the Council of Logistics Management by James R. Stock, Executive Summary, ii-v.

1. **Solid Waste Effort Design**

The research identified how corporate solid waste management efforts have influenced purchasing operations, how corporate solid waste reduction efforts have changed over the last three years, and how they will change over the next three years. Understanding how corporate solid waste reduction efforts affect the purchasing function will aid in designing an on-going corporate solid waste reduction plan. The research examined setting corporate solid waste reduction goals and how the results are measured to provide insight to the issues and solutions to goal setting and measurement.

2. **Understanding Changes to the "Buy" Decision**

The research examined how corporate solid waste management has influenced the "buy" decision by determining how decision factors have been modified over time and how they will influence the "buy" decision in the future. The research suggested leverage points within purchasing "buy" decision where solid waste reduction with suppliers can best be implemented. Understanding how the "buy" decision will change may serve as a guide for training purchasing personnel.

3. **Changing Roles and Responsibilities of Purchasing**

The research examined the effects corporate solid waste management efforts have had on functional relationships of purchasing within the firm. It offers insights into the changing roles and responsibilities of the purchasing function, skill requirements and resource requirements over the last three years and projected for the

next three years. The research may help guide the development of the purchasing function in the future.

4. Changing Relationships Between Customers and Suppliers

The research examined if corporate solid waste reduction efforts between customers and suppliers have altered relationships by changing the requirements or expectations of the channel members over the last three years and projected changes over the next three years. The findings may be used to design a corporate solid waste reduction plan which effectively utilizes the ability of purchasing to manage the supply chain and involve key suppliers.

5. Lessons Learned From the Successful Industrial Practice

The research examined "successful practices" from industry. It examined what went right and what the companies would do differently in corporate solid waste management efforts. The knowledge gathered was used to characteristics of the purchasing function of a best practice company addressing solid waste reduction issues. Identification of how a best practice company reduces solid waste can be used as a guide for companies which would like to begin or advance their solid waste reduction effort.

Organization of this Study

This document consists of five chapters. The purpose of this chapter was identify the general research area, explain the need for this research, familiarize the reader with the main problem addressed, and pro-

vide a brief description of the methodology, limitations, and potential contributions.

The development of the literature relevant to this research effort and supporting the research questions is presented in Chapter Two.

The research design and methodology are developed in Chapter Three. Key research variables are defined and the specific hypotheses underlying this research are presented in this chapter.

The data analysis involved in testing the research hypotheses is presented in Chapter Four. This chapter also contains an explanation of findings not specifically identified in the research hypotheses.

The concluding chapter contains a summary of the research effort and a discussion of the conclusions drawn from the findings. The implications of the research as related to theory and practice and suggestions for future research are also developed in this chapter.

Several appendices that explain and illustrate the research design and methodology are included. The appendices include a glossary of terms, copies of the pre-notification letter, notification telephone message, NAPM survey cover letter, and written survey, case study interview protocol, and a profile of each of the firms involved in the case studies.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The following review of the literature provides an overview of the evolution of solid waste management in the United States and internationally, identifying key components and issues, exploring governmental and industrial efforts to manage the solid waste stream, and provides a framework explaining why a corporation should manage their solid waste stream.

The review provides a framework explaining the evolution of purchasing operations and identifies the role of purchasing in solid waste management activities. The review identifies current information regarding how corporate environmental activities affect purchasing operations. Finally, the review will identify the gaps in the literature which will be addressed by this study.

Background

The Modern Environmental Movement

The modern environmental movement is cited³ as originating with the 1962 publication of *Silent Spring*⁴ by Rachel Carson citing the dangers of agricultural pesticides and chemicals such as DDT. Other notable writings, such as Erlich's *The Population Bomb*,⁵ Commoner's *The Closing Circle*,⁶ and Massachusetts Institute of Technology's *Limits to Growth*,⁷ started to identify environmental concerns and called for im-

³Rathje, William L. and Cullen Murphy, *Rubbish*. Harper Collins Books, 1992. p. 191.

See also Nash, Tom, "Green About the Environment?" *Director*, Volume 43, Issue 7, February 1990, p. 40. Eisenhart, Tom, "There's Gold in That Garbage!" *Business Marketing*, Volume 75, Issue 11, November 1990, p. 20. Ashton, Robin; Erickson, Greg; Larson, Melissa "Reducing Solid Waste," *Packaging*, Volume 36, Issue 5, April 1991, p. 24. Baran, Josh "Every Day Is Earth Day," *Public Relations Journal*, Volume 47, Issue 4, April 1991, p. 22. E. Joseph Stilwell, R. Claire Canty, Peter W. Kopf and Anthony M. Montrone, *Packaging for the Environment: A Partnership for Progress*, New York: AMACOM, 1991, p. 7.

⁴Carson, Rachel *Silent Spring* Boston, Houghton Mifflin, 1962.

⁵Erlich, Paul R. *The Population Bomb* New York, Ballantine Books, 1968.

⁶Commoner, Barry *The Closing Circle: Nature, Man, and Technology* New York, KNOFF, 1971.

⁷Meadows, Donella H. [and others] Massachusetts Institute of Technology *The Limits to Growth*, New York, Universe Books, 1972.

proved utilization of natural resources, reduced pollution, population control, and understanding of the cause-and-effect of our actions on the environment.

In 1970, the Club of Rome, invited Jay Forrester and Massachusetts Institute of Technology to utilize the "systems dynamics" approach to "explore more deeply the underlying assumptions and several major sub-systems that formed the sectors of the total world system."⁸ The work supported the "Predicament of Mankind" project. The objective of the project was "to understand the options available to mankind as societies entered the transition from growth to equilibrium." The systems dynamics approach integrated such factors as capital investment, population, natural resources, quality of life, and pollution to reflect the attitudes and motivations of past and current lifestyles. In his book, *World Dynamics*, Forrester sums the result of the model as "hope [this work] contributes to the sense of urgency and points to an effective direction for work by others who may choose to explore the alternatives for the future."⁹

Increased awareness of environmental issues was furthered with the first "Earth Day" celebration on April 22, 1970. National organizations such as the Sierra Club, the Audubon Society, the National Wildlife Federation, and the Wilderness Society brought litigation and lobbied for stricter laws dealing with almost every aspect of the environment. These

⁸Forrester, Jay W. *World Dynamics*. Wright-Allen Press, 1971. p. viii.

⁹Forrester, *Op cit.* p. ix.

laws included the National Environmental Policy Act of 1969, the Clean Water Act of 1972, the National Forest Management Act of 1976, the Clean Air Act amendments of 1977, and the National Acid Precipitation Act of 1980, as well as the creation in 1970 of the Environmental Protection Agency.

Energy issues and economic conditions in the late 1970s and early 1980s focused public awareness away from environmental concerns. The cause resurfaced in the late 1980s and carried into the 1990s "due to events such as the acid rain controversy, the Chernobyl nuclear accident, the Exxon Valdez oil spill, tropical deforestation, global warming, garbage barges and garbage trains, and limitations of landfill space."¹⁰

The original focus of the 1960's, conservation and reduction of environmental hazards, has been joined with increasing concern over solid waste. In a 1991 study, three out of four Americans were concerned about the environment and were making changes in their daily lives that reflect the concern.¹¹ By 1995, consumers are projected to spend \$8.8 billion on environmentally friendly, or "green," products, nearly five times more than the \$1.8 billion spent in 1990.¹²

¹⁰Stilwell, et. al. *Op cit.* pp. 7-10.

¹¹Baran, Josh "Every Day Is Earth Day," *Public Relations Journal*, Volume 47, Issue 4, April 1991, pp. 22-23.

¹²Hemphill, Thomas A., "Marketer's New Motto: It's Keen to Be Green," *Business & Society Review* Issue 78, Summer 1991, pp. 39-44.

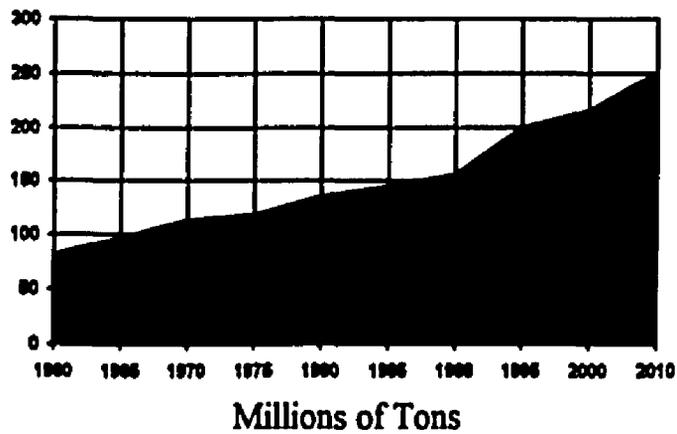
The Growing Solid Waste Problem

Solid waste is one of the environmental problems that continues to grow. As shown in Figure One, the 156 million tons of solid waste generated in the United States in 1988 was almost twice the amount generated in 1960. Projections for the future suggest continued growth in the total tonnage of solid waste generated in the United States.¹³ Per capita use of bottles, cans, boxes, wrappers, and other packaging increased by 63 percent in the United States between 1958 and 1976.¹⁴ The average U.S. household discards the equivalent of about 350 large garbage bags per year, twice the amount of garbage generated by the average European household and almost 2 1/2 times the amount of garbage generated by the average Japanese household.¹⁵

¹³*Statistical Record of the Environment*. Arsen J. Damay, Editor, Gale Research, Inc. 1992, pp. 109 - 110; reprinted from *Characteristics of Municipal Solid Waste in the United States: 1990 Update*. U.S. Environmental Protection Agency, EPA/530-SW-90-042, Washington, D.C., June 1990, p. 46.

¹⁴Stilwell, et. al. *Op cit.*, p. 2.

¹⁵*Household Consumers and Packaging: An Overview of Current Trends, Initiatives and Implications for the National Packaging Protocol*, Canadian Council of Ministers of the Environment, May 1990. p. 7-1.



Products	1960	1965	1970	1975	1980	1985	1988
Containers & packaging	24.2	31.1	39.6	39.3	42.1	42.2	43.0
Other waste	57.7	65.5	73.7	78.9	93.0	102.8	113.0
Total	81.9	96.6	113.3	118.2	135.1	145.2	156.0

Products	Projected		
	1995	2000	2010
Containers & packaging	61.9	65.7	75.8
Other waste	137.9	150.3	174.8
Total	199.8	216.0	250.6

Figure 1

Historical Municipal Waste Stream - Weight¹⁶

¹⁶Damay, *Op. cit.*, p. 46, 66.

Landfill Limitations

Americans dump over 160 million tons of trash annually, or about 1,300 pounds per person.¹⁷ Solid waste may be buried in a landfill, recycled, or incinerated. In the United States, 85% of the solid waste produced goes to landfill sites, 11% recycled, and 4% incinerated. Table One shows the estimated remaining years of landfill capacity by state. Siting of new landfills is becoming increasingly difficult¹⁸ due to stricter environmental regulations and local attitudes against providing landfill space for non-residents. Dr. William Rathje cites an environmental study commissioned by Browning Ferris Industries, of eastern New York State to determine where landfills might safely be located.

"The survey pinpointed sites that constituted only 1% of the region's land area representing 200 square miles of territory. Yet with all this potentially available land, the state of New York has since 1982 closed down 298 landfills and opened only six."¹⁹

Higher landfill tipping fees (shown in Figure Two and Figure Three) reflect limited availability of open landfills in the northeastern U.S. The increasing cost of solid waste disposal may be one of the motivating

¹⁷Lallande, Ann "Environmental Marketing: The Next Wave," *Marketing and Media Decisions*, Volume 23, Issue 12, December 1988, pp. 174,176.

¹⁸Lallande, *Op. cit.*

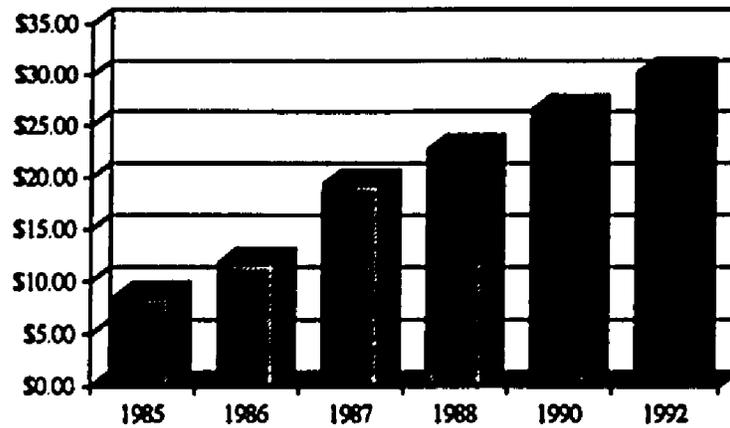
¹⁹Rathje, *Op. cit.*, p. 109.

Table 1

Remaining Years of Landfill Capacity in the 48 Contiguous States²⁰

1 - 5 Years	5 - 10 Years	10 + Years
Connecticut	Alabama	Arizona
Kentucky	Colorado	Arkansas
Massachusetts	Delaware	California
New Jersey	Florida	Georgia
Ohio	Illinois	Idaho
Pennsylvania	Indiana	Iowa
Rhode Island	Maine	Kansas
Virginia	Maryland	Louisiana
West Virginia	Michigan	Mississippi
	Minnesota	Nebraska
	Missouri	Nevada
	Montana	New Mexico
	New Hampshire	North Carolina
	New York	North Dakota
	Oklahoma	Oregon
	Vermont	South Carolina
		South Dakota
		Tennessee
		Texas
		Utah
		Washington
		Wisconsin
		Wyoming

²⁰Stilwell, et. al. *Op cit.*, p.105.

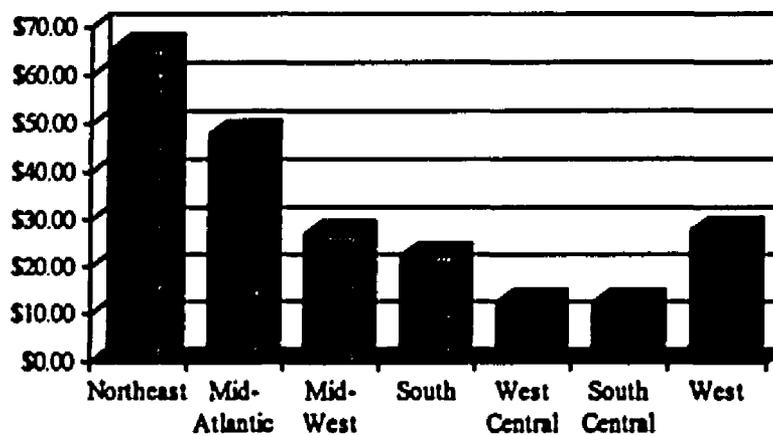


Year	Rate per Ton
1985	\$ 8.57
1986	\$11.81
1987	\$19.40
1988	\$22.74
1990	\$26.56
1992	\$30.21

Figure 2

Average Landfill Tipping Fees in the U.S.²¹

²¹ Repa, Edward, "Landfill Tipping Fees, 1992." National Solid Wastes Management Association.



Region	Rate per Ton
Northeast	\$65.83
Mid-Atlantic	\$47.94
Midwest	\$27.10
West Central	\$12.62
South Central	\$12.53
West	\$27.92

Figure 3

Average Tipping Fees By Region of the U.S. in 1992²²

²² Repa, Edward, "Landfill Tipping Fees, 1992." National Solid Wastes Management Association.

factors encouraging businesses to embrace environmental awareness in their business practice.

Introducing Legislative Action

Legislation may serve as the catalyst to adopt an environmental policy. According to Bob James of Battelle Columbus Operations, during the 1990's, there will be more regulatory pressure on packaging material due to environmental issues than ever before.²³ In 1990, public pressure spurred more than eight hundred proposals for laws regulating solid waste.²⁴ Environmental legislation may take place at the following levels:

1. Federal and State Government
2. Environmental Protection Agency
3. Federal Trade Commission
4. City and Local Governments

1. Federal and State Government

Consumers, environmental organizations, regulatory bodies, and industry coalitions are all trying to define and regulate which products can be called green and how those items can be sold. The federal government "does not have an overall green-marketing policy, a situation that clearly

²³Vasilash, Gary S. "Materials: A Glance Back & Forth and Beyond," *Production*, Volume 102, Issue 5, May 1990, pp. 72-73.

²⁴Morris, Gregory D.; Kiesche, Elizabeth S.; Rotman, David; Wood, Andrew; Flam, Faye "Filling New Needs in Packaging," *Chemical Week*, Volume 147, Issue 3, July 25, 1990, pp. 26-34.

leaves companies in a bind" as they continue to battle with various state legislators who have enacted their own laws governing environmental terms.²⁵ The federal government has clout through its buying power. Guidelines from the United States Office of Management and Budget call for agency procurement officers to develop affirmative procurement programs for several classes of recycled products.²⁶ The guidelines apply to all procuring agencies spending \$10,000 or more annually on any item covered.²⁷

The primary mandate of the Federal Resource Conservation and Recovery Act required state solid waste management plans to make source reduction an integral part of the planning process. Each state establishes individual goals for the amount of solid waste it would reduce annually.²⁸

²⁵Voss, Bristol "The Green Marketplace," *Sales & Marketing Management*, Volume 143, Issue 8, July 1991, pp. 74-76.

²⁶Barron, Tom, "Federal "Buy Recycled" Policy Finds Narrow Common Ground," *Environment Today*, Volume 3, Issue 5, June 1992, pp. 3, 25-26 .

²⁷MacDonald, Ann, " How Effective Are Federal Procurement Policies?" *BioCycle*, Volume 32, Issue 9, September 1991, pp. 47-49.

²⁸Darcey, Sue, "Congress Takes a Swing at the Recycling Logjam," *World Wastes*, Volume 35, Issue 4 April 1992, pp. 118b-118c, 121-124.

In 1990, thirty-nine states and the District of Columbia had a policy favoring recycled products.²⁹ The states account for 92.5% of the population of the United States. Table Two shows an example of the recycling goals of some of the states. States are also using a variety of techniques such as tax incentives, procurement policies, minimum content legislation, and grants and loans to encourage industries to use recyclable materials.³⁰

According to a report issued by the National Conference of State Legislatures, municipal solid waste management dominated the environmental agendas of state legislatures in 1991. Over 60% of the respondents, which included legislators and their aides from forty-nine states, Puerto Rico, and the District of Columbia, cited solid and hazardous waste disposal as a top priority, while 30% ranked it as their number one environmental concern.³¹

²⁹Bertrand, Kate, "Government Boosts Market for Recycled Products," *Business Marketing*, Volume 75, Issue 11, November 1990, p. 36.

³⁰Steuteville, Robert, "State Market Initiatives: Economic Development in the Recycling Arena," *BioCycle*, Volume 33, Issue 8, August 1992, pp. 40-44.

³¹Greenberger, Leonard S. "State Legislatures Rank 1991 Priorities," *Public Utilities Fortnightly*, Volume 127, Issue 5, March 1, 1991, pp. 37-38.

Table 2
State Recycling Goals and Deadlines³²

State	Reduction Goal	Deadline
California	50%	2000
Connecticut	25%	1991
DC	45%	1994
Delaware	30%	1994
Florida	30%	1994
Georgia	25%	1996
Illinois	25%	2000
Indiana	50%	2001
Iowa	50%	2000
Louisiana	25%	1992
Maine	50%	1994
Maryland	20%	1994
Massachusetts	56%	2005
Michigan	50%	2005
Minnesota	25%	1993
Mississippi	25%	1996
Missouri	40%	1998
New Hampshire	40%	2000
New Jersey	25%	1992
New Mexico	50%	2000
New York	50%	1997
North Carolina	25%	1993
Ohio	25%	1994
Pennsylvania	25%	1997
Vermont	40%	2000
Virginia	25%	1995
Washington	50%	1995
West Virginia	30%	2000

³²*Reverse Logistics*, a white paper prepared for the Council of Logistics Management by James R. Stock.

The drawback to environmental legislation at the state level is that state legislation provides widely different definitions of the terms recycled and recyclable.³³ State legislation is subject to local interests. Some state and local legislators have introduced antipackaging legislation seeking to set new recycling rates, ban nonrecyclable containers, and force changes in packaging.³⁴ The affect on business is the need to cope with inconsistent environmental legislation that varies from state to state. One solution is to attempt to meet the strictest legislation, a solution similar to the one used by some automobile manufacturers in meeting California emissions standards.³⁵ As the strictest standard, many marketing executives foresee a future legal environment that will prohibit the sale of nonrecyclable and non-biodegradable consumer goods.³⁶

2. Environmental Protection Agency

The Environmental Protection Agency has outlined a hierarchy of solid waste reduction programs to be considered for integrated waste management. The Recyclable Materials Science and Technology Devel-

³³Lawrence, Jennifer, "Marketers Drop "Recycled"," *Advertising Age*, Volume 63, Issue 10, March 9, 1992, pp. 1,48.

³⁴Ashton, Robin; Erickson, Greg; Larson, Melissa "Reducing Solid Waste," *Packaging*, Volume 36, Issue 5, April 1991, pp. 24-32.

³⁵Scerbinski, Jacqueline S., "Consumers and the Environment: A Focus on Five Products," *Journal of Business Strategy*, Volume 12, Issue 5, September/October 1991, pp. 44-47.

³⁶Cairncross, Frances, "How Europe's Companies Reposition to Recycle," *Harvard Business Review*, March-April 1992, p. 36.

opment Act require the Department of Commerce to recommend measures for ensuring the development of technologies for recycling nondurable consumer product packaging, the expansion of markets for recycled products, and the creation of biodegradable consumer products.³⁷

3. Federal Trade Commission

The Federal Trade Commission is working toward issuing guidelines on environmental claims for both product labels and advertising. Its first priority is to eliminate deception in the marketplace in the area of environmental terms.³⁸

4. City and Local Governments

To further complicate the regulatory problems, city and local governments also have the power to enact environmental ordinances. Newark, New Jersey, was the first city with a mandatory recycled content purchasing program. In 1990, the city adopted the Recycled Product Procurement Ordinance, mandating waste reduction and reuse of materials where possible and requiring the purchase of recycled materials, such as copy paper.³⁹ In 1993, waste haulers in Tucson, Arizona, fought a proposed local ordinance requiring haulers to rebate 20% of their pick-up

³⁷Lallande, *Op. cit.* pp. 174, 176.

³⁸Rosendahl, Iris, "Environmental Claims Abound as Hunt for Guidelines Goes On," *Drug Topics*, Volume 135, Issue 6, March 25, 1991, pp. 59-60.

³⁹Sudol, Frank, "A "Buy Recycled" Program That Works," *American City & County*, Volume 107, Issue 9, August 1992, p. 18.

fee to their customers if the customers recycle.⁴⁰ The proposed ordinance was a result of a study projecting a 20% reduction in landfill requirements as a result of voluntary recycling. The waste haulers argued that while their landfill tipping fees would indeed drop by 20%, the tipping fee represented less than 15% of their total costs and they were still obligated to incur the expenses of picking up the recycled materials for transporting to county consolidation locations.

Increasing Legislative Focus

Environmental legislation has been directed toward solid waste stream reduction and recycling due to rising constituency concerns and as a means of reducing government spending. Many state and local legislative bodies are emphasizing stricter budget scrutiny. Solid waste management ranks third after schools and roads in most municipal budgets in the United States.⁴¹ In many communities, solid waste management is a fast growing budget item. Many local governments have controlled the growth of waste management costs by recycling up to 40% of the total solid waste they produce.⁴²

⁴⁰Personal interview with Edwin Caywood, President of CPI-Rincon Valley Sanitation, Rincon Valley, Arizona on January 12, 1993.

⁴¹"Multi-Material Recycling Manual." *The Keep America Beautiful System. Revised Edition.* 1987, 116 pages.

⁴²"Why Waste a Second Chance? A Small Town Guide to Recycling." *National Association of Towns and Townships*, Washington, DC., 1989, 46 pages.

Threat of Legislation

If perceived solutions to environmental problems are legislated, this may reduce the options a business has to resolve the problem. For this reason, legislation or the threat of legislation is an on-going concern for the corporation. Enactment of a corporate solid waste policy must consider legislation, current and potential, in each market served.

The International Environmental Scene

Environmentalism is prevalent in countries such as Germany, Italy, Switzerland, the Netherlands, France, and Canada. The international environmental scene may be a precursor of future environmentalism in the United States.

Environmental political units, known as the Green Party, are stronger in Europe than in the United States.⁴³ The West German Green Movement was an outgrowth of West Germany's Citizens Initiative Movements that started in the 1950's. The Belgian Greens first gained national representation in 1981. The French Green party has had strong growth, particularly on the local scene. Several French cities, including Strasbourg, have elected Green mayors. The British Green Party began as the People's Party in 1973, became the Ecology Party in 1975, and the Green Party in 1985.⁴⁴

⁴³Stilwell, et. al. *Op cit.*, p.114.

⁴⁴Stilwell, et. al. *Op cit.*, p.114.

Germany

In 1989, Klaus Toepfer, Germany's environment minister, encouraged shoppers to shame companies into reducing packaging bulk by stripping off excess wrappings from their purchases and dumping them at the checkout counter.⁴⁵ Germany is the "European equivalent of California; the continent's biggest, richest country with the largest amount of waste and the strongest environmental lobby."⁴⁶ Germany's packaging ordinance, passed in April 1991, is probably the most ambitious environmental legislation any nation has ever attempted. It obliges retailers to take back packaging from customers, product manufacturers to retrieve it from retailers, and packaging suppliers to reclaim it from product manufacturers. The process began in December 1991 and will be completely phased in by 1993.⁴⁷ When packaging arrives at the packager's doorstep, it cannot simply be tossed into a landfill. Once the system is in place, 80% of all packaging must be collected, and of that, 90% of glass, tin, and aluminum and 80% of other packaging must be separated and recycled.⁴⁸ Paul Knocker, vice president of environmental affairs for Continental Can in Europe, points out that the "German plan includes all packaging, while North American schemes go for three or four easily handled wastes."⁴⁹

⁴⁵Cairncross, Frances, "How Europe's Companies Reposition to Recycle," *Harvard Business Review*, March-April 1992, p. 36.

⁴⁶Cairncross, *Op. cit.*, p. 35.

⁴⁷Cairncross, *Op. cit.*, p. 36.

⁴⁸*Ibid.*

⁴⁹Cairncross, *Op. cit.*, p. 38.

In response to the German legislative efforts, over 400 companies have taken shares in *Duales System Deutschland (DSD)*. DSD will organize nationwide recycling of all household cast-off packaging. The hallmark of the DSD plan is a prominent green dot. Over 16,000 companies have signed contracts that permit them to display the dot on their packaging for a fee. The green dot guarantees that the package can be recycled. Households separate items with the dot from the rest of their trash and put them in special yellow trash cans at curbside. Contractors collect the contents and take them to one of 200 sites now under construction. Trash is sorted and sent back to the originating companies for further recycling.⁵⁰

German restrictions on one-trip bottles and packaging have led to claims of trade protection. A rule that 72% of drink containers must be refillable was included in German legislation at the last moment, infuriating packagers in France and Britain who saw it as a device to protect small but politically powerful Bavarian brewers from foreign competition.⁵¹

⁵⁰*Ibid.*

⁵¹Cairncross, *Op. cit.*, p. 40.

Italy

Italy has set recycling targets of 50% for glass and metal drink containers and 40% for plastic ones to be met in 1993.⁵²

Switzerland

Switzerland has aimed to reduce the weight of glass bottles in the solid waste stream by half between 1988 and 1993 and of aluminum cans by one-third.⁵³

The Netherlands and France

The Netherlands and France are tackling the whole range of packaging waste. The governments have worked closely with industry to implement policy on solid waste.⁵⁴ Manufacturers have agreed to take back 90% of all used packaging by the end of the century. As in Germany, industry, not government, will bear the cost.⁵⁵

Canada

The Canadian Council of Ministers of the Environment developed the National Packaging Protocol that calls for the overall reduction in waste generation of 50% by the year 2000. It requires that 50% of pack-

⁵²Cairncross, *Op. cit.*, p. 38.

⁵³*Ibid.*

⁵⁴*Ibid.*

⁵⁵*Ibid.*

aging in the solid waste management stream be diverted from landfill by the year 2000, using primarily reduction, reuse, and recycling.⁵⁶

Efforts in Europe and Canada may provide insights to the direction of solid waste management in the United States. Governments strike deals with companies that persuade them to move further and faster than legislation would impel them to go; in exchange, these companies assume more control over the timetable and are offered some protection from attacks by nongovernment organizations.⁵⁷ European trends are extending the responsibility for packaging material all the way back to the original supplier suggesting the need to link customer solid waste efforts with supplier solid waste efforts.

Packaging Material: The Largest Component of the Solid Waste Stream

There are opportunities to extend the life of current landfills and more effectively utilize our resources. As the largest component of both the consumer and commercial solid waste streams, packaging material is targeted as offering the greatest leverage for solid waste reduction.⁵⁸ ⁵⁹

⁵⁶*Economic Considerations in the Development of the National Packaging Protocol.* Canadian Council of Ministers of the Environment, May 1990.

⁵⁷Cairncross, *Op. cit.*, p. 38.

⁵⁸Stilwell, et al. *Op. cit.* p. 2.

⁵⁹*Household Consumers and Packaging: An Overview of Current Trends, Initiatives and Implications for the National Packaging Protocol.* Canadian Council of Ministers of the Environment, May 1990. p. 7-1.

Studies of household garbage content indicate packaging material usually make up over 30% by weight and 50% of the volume of household waste.⁶⁰ Table Three identifies the recyclable content of the commercial solid waste stream. "Packaging material and containers" may include corrugated paper, some newspaper or mixed recyclables as wrapping papers and dunnage, some ferrous metals for strapping, and plastic wraps. While the content of commercial solid waste stream varies from industry to industry, packaging material and containers often represents the largest component of the commercial waste stream.

Table Four and Figure Four identify the typical waste content of a municipal landfill. In the combined consumer and commercial solid waste stream, packaging material and containers comprise the largest component of the solid waste stream. They are also the most rapidly expanding component of solid waste, having risen from 24.2 million tons in 1960 to 43.0 million tons in 1988.⁶¹ It has been suggested that reuse, reduction, and recycling of packaging materials offers the greatest opportunity for the reduction of the solid waste stream.⁶²

⁶⁰Marinelli, Janet, "Garbage At the Grocery," *Garbage*, September/October 1989, pp. 34-39.

⁶¹Coalition of Northeastern Governors (CONEG), *Final Report of the Source Reduction Task Force*. (September, 1989) p. 13.

⁶²Allaway, David, "Does Source Reduction Work?" *Resource Recycling*, July 1992, pp. 52-61.

Table 3
Recyclable Materials in Commercial Waste⁶³

Waste Component	Retail Trade	Restaurant	Office	School	Govt
Paper	41.5%	36.6%	64.2%	47.8%	53.8%
Newspaper	2.9%	2.5%	3.6%	3.3%	6.7%
Corrugated	22.0%	15.6%	11.5%	11.6%	8.4%
High grade white paper	1.4%	0.0%	10.6%	6.3%	7.2%
Mixed recyclable	10.3%	4.4%	29.0%	21.6%	25.0%
Nonrecyclable	4.9%	14.1%	9.5%	5.0%	6.5%
Plastic	12.0%	13.7%	4.3%	5.1%	3.5%
Polyethylene	0.1%	0.0%	0.1%	0.1%	0.1%
High density polyethylene	0.0%	0.1%	0.0%	0.0%	0.0%
Other	11.9%	13.6%	4.2%	5.0%	3.4%
Glass	2.5%	5.9%	3.9%	3.2%	2.7%
Containers	2.3%	5.8%	2.9%	1.0%	2.4%
Nonrecyclable glass	0.2%	0.1%	1.0%	2.2%	0.3%
Metal	20.5%	4.9%	2.9%	5.8%	9.8%
Aluminum cans	0.2%	0.5%	0.5%	0.8%	0.5%
Tin/steel cans	0.2%	3.8%	0.2%	0.2%	0.4%
Other ferrous	19.5%	0.4%	2.2%	3.7%	8.6%
Other nonferrous	0.6%	0.2%	0.0%	1.1%	0.3%
Organics	18.8%	36.6%	10.8%	35.0%	23.2%
Food waste	8.1%	36.0%	3.0%	14.0%	3.2%
Yard debris and wood	10.7%	0.6%	7.8%	21.0%	20.0%
Other	4.7%	2.3%	13.9%	3.1%	7.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

⁶³Darney, *Op. cit.* p. 50.

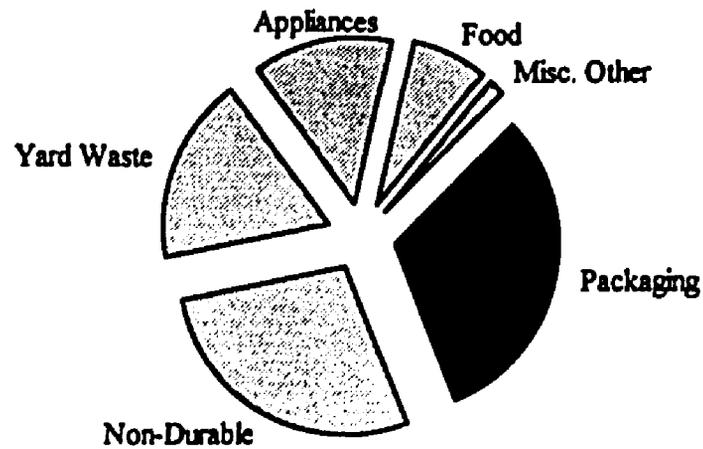
Table 4

Products in the Municipal Waste Stream⁶⁴

Percentage of total discards before materials recovery or combustion.

Products	1960	1965	1970	1975	1980	1985	1988	Projected		
								1995	2000	2010
Durable Goods	10.7	10.7	12.4	13.7	13.2	13.3	13.9	14.3	14.5	14.3
Nondurable Goods	20.0	21.5	20.9	20.0	24.4	26.4	28.1	30.3	31.6	34.4
Containers & Packaging	31.1	33.1	35.7	34.7	33.8	32.1	31.6	31.0	30.4	30.2
Food Waste	13.9	12.3	10.5	10.5	8.8	8.2	7.4	6.6	6.2	5.5
Yard Waste	22.8	20.9	19.0	19.7	18.4	18.6	17.6	16.5	15.9	14.4
Misc. Other	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2
TOTAL	100.0									

⁶⁴ Damay, *Op. cit.*, p. 43.



Item	Percentage of Total Volume
Packaging and Containers	31.6%
Non-durable goods	28.1%
Yard Waste	17.6%
Durable Goods	13.9%
Food Waste	7.4%
Misc. Other	1.5%

Figure 4

Typical Waste Content of a Landfill By Volume in 1988⁶⁵

⁶⁵ Darney, *Op. cit.*, p. 43.

Advantages of Corporate Solid Waste Management

Solid waste stream reduction efforts should not be limited to the residential community. Waste from business accounts for 40% of the United States' solid waste stream, and 80% of that waste could be recycled.⁶⁶ As waste disposal costs increase and companies are increasingly graded on their citizenship, we can expect to see more environmental awareness and increasing stewardship of resources by business.

Corporate actions to reduce solid waste offer financial benefits for the firm, for example, reduced waste disposal fees. Alternative packaging or forms of product may result in reduced packaging material costs and transportation savings. For example, Proctor & Gamble started offering Downy softener in a liquid concentrate form. After the correct amount of tap water is added, the concentrate yields an equivalent amount of softener as traditionally sold. The concentrate bottle is one-fourth the size of the traditional bottle. A truckload shipment of the concentrated product has the equivalent sales potential of four truckload shipments of the traditional Downy product in the larger bottles. The alternative form of the Downy concentrate has allowed Procter & Gambles to achieve packaging and transportation savings.

⁶⁶Pond, James S., "Recycling in America: Business Cleans Up Its Act," *Today's Office*, Volume 25, Issue 10, March 1991 pp. 33-46.

Roy and Whelan suggest there are a variety of reasons that may motivate a company to consider the environment in their strategic plan shown in Table Five.⁶⁷ These reasons include perception as a good corporate citizen, financial cost, reduced uncertainty, and preparation for future legislation. Porter and Cannon suggest the motivation can be summarized into economics and the economic self-interest of the individual corporation.⁶⁸

Environmental issues have become so dominant that world-class corporations are finding ways to integrate environmental planning into their business strategies.⁶⁹ A survey of executives found that pressures for increased environmental protection affect corporate strategic planning and operational procedures.⁷⁰

⁶⁷Roy, R., and R. C. Whelan, "Successful Recycling Through Value-Chain Collaboration," *Long Range Planning*, Volume 25, Number 4, 1992, p. 70.

⁶⁸Porter, J. Winston, and Jonathan Z. Cannon, "Waste Minimization: Challenge for American Industry," *Business Horizons*, March-April 1992, p.48.

⁶⁹Barnes, A. James, and Janice K. Ferry, "Creating a Niche for the Environment in the Business School Curriculum," *Business Horizons*, March-April 1992, p. 4.

⁷⁰Vandermerwe, Sandra; and Micheal D. Oliff, "Customers Drive Corporations Green," *Long Range Planning*, Volume 23, Issue 6, December 1990, pp. 10-16.

Businesses are under pressure to adopt environmental policies and incorporate them into their strategic business planning. Coli Hutchinson, Chairman of the Conservation Trust, suggests these pressures come from at least five sources -- stricter legislation, consumer demand, competitive advantage, staff concerns, and community pressure.⁷¹ Others suggest environmental policies are incorporated into strategic plans as a marketing niche⁷² or as an additional financial opportunity during an economic slowdown.⁷³

Many industries have responded to the advantages and pressures to address environmental issues. Schlossberg cites a survey conducted by Gerstman+Meyers that reports 75% of corporate executives indicated their companies were addressing the solid waste problem.⁷⁴ In a 1992 survey of grocery CEOs shown in Table Six and Table Seven, Langrehr, Langrehr, and Tatreau suggest the awareness level of the grocery industry is very

⁷¹Hutchinson, Coli, "Environmental Issues: The Challenge for The Chief Executive," *Long Range Planning*, Volume 25, Number 3, p. 50.

⁷²Barnes, Phillip E. "Business' Hottest Niche Market: The Environment," *Business & Economic Review*, Volume 37, Issue 3, April-June 1991, pp. 7-11.

⁷³Snodgrass, Tod, " Ideal Overhead: Lean and Mean," *Credit Union Management*, Volume 14, Issue 4 , April 1991 pp. 44-45.

⁷⁴Schlossberg, Howard, "Solid Waste Issue Overshadowed by Global Warming," *Marketing News*, Volume 26, Issue 15, July 20, 1992, p. 13.

Table 5
Management of Solid Waste and Recycling⁷⁵

Issue	Benefit
Corporate position	Better image, greater appeal to customers, and employees
Future liabilities	Reduction of future uncertainty, greater preparation
Effluent monitoring	Lower material costs; lower waste disposal costs
In-plant recycling	Lower material costs, lower disposal costs, marketing advantage
End-of-Life product recycling	Lower material and disposal costs, reduced dependence on other disposal means, e.g. landfill, preparation for future legislation, company image

⁷⁵Whelan, *Op. cit.*, p. 70.

Table 6
Opinions About Solid Waste Management and Recycling⁷⁶

Opinion	Mean	SA	A	N	D	SD
Solid waste management is a major problem in the United States	1.2	85	11	0	4	0
Solid waste management is a problem at the consumer level	1.9	43	43	0	7	7
Solid waste management is a problem at the manufacturer level.	1.7	43	50	0	7	0
The food industry could reduce the total waste stream in the United States by changing its packaging methods	2.3	25	50	7	11	7
It is a waste of effort to recycle products because all products eventually become waste.**	4.9	0	0	0	14	86
Purchasing policies of private industry have little impact on the total production of recycled products.**	4.5	0	4	0	36	60
Our company would increase recycling activities regardless of the availability of financial incentives.	2.0	36	46	7	7	4
Our company would increase recycling if we would receive a 5% tax reduction to do so.	2.8	11	36	28	18	7

Responses were rated on a 5-point scale where 1 = strongly agree and 5 = strongly disagree
 **Reverse coded statement where the higher the mean value, the more environmentally concerned

⁷⁶Langrehr, Virginia B., Frederick W. Langrehr, and John Tatreau, "Business Uses' Attitudes Toward Recycled Materials, *Industrial Marketing Management*, Volume 21, 1992, pp. 361-367.

Table 7
Specific Actions Related to Solid Waste Management⁷⁷
Grocery CEO Survey Results

	Yes (%)	No (%)
The company has a written or unwritten policy on:		
Purchasing recycled materials	71	29
Selling recyclable waste	79	21
The company has a policy of reducing waste by substituting lighter, more compact materials for heavier, bulkier materials in the following areas:		
Packaging	89	11
Shipping containers	82	18
Product design	65	25
The company knows suppliers for:		
Recycled paper	96	4
Recycled plastic	64	36
The company currently purchases:		
Recycled paper	77	28
Recycled plastic	29	71
The company internally reuses scrap:		
Paper**	25	57
Plastic**	43	46

**11% responded "I don't know"

⁷⁷Langrehr, et. al. *Op. cit.* p. 365.

high and this is indicative of consumer wishes.⁷⁸ The survey results indicate the grocery industry has already started implementing corporate solid waste management programs.

Surveys and studies found in the literature identify company involvement in solid waste reduction but fail to investigate how functional areas, such as purchasing, are involved or affected by effort.

Recycling Items From the Corporate Solid Waste Stream

Recycling material after it enters the solid waste stream is the most visible and popular form of corporate waste stream management in part because of the potential revenue coming from the sale of the material. It offers a benefit of reducing the amount and cost of hauling and disposal services required.

Sun Microsystems recovered \$7.5 million over two years by recycling from manufacturing plants, according to the company's Leonard Murray. In the first month of an office recycling drive, Sun cut by 50% its trash headed for the landfill, and the company expects to save approximately \$115,000 a year in hauling costs at its headquarters site alone. Start-up costs were estimated at \$20,500.⁷⁹

⁷⁸Langrehr, *Op. cit.*, pp. 361-367.

⁷⁹Savage, J. A. "Vendors Step Up Recycling Efforts," *Computerworld*, Volume 25, Issue 26, July 1, 1991, pp. 1-62.

All of Minnesota Mining and Manufacturing's plants are actively reducing their waste volume, starting with mixed-paper waste. Annual office paper collection at Minnesota Mining and Manufacturing increased by 600,000 pounds to 3 million pounds in 1990. The firm saved \$241,000 for the year, of which \$64,000 came from selling collected paper and \$177,000 was saved from not requiring hauling and disposal service.⁸⁰

Recycling plays an important role in corporate waste stream reduction and usually receives the most publicity within the corporation. While recycling is an important part of the corporate environmental effort, it addresses the waste after the material has entered the company waste stream. Additional emphasis and effort should be focused on the avoidance or reduction of material entering the corporation that ultimately will end up in the corporate waste stream.

Reusable Containers

Reusable containers may be a part of a solid waste reduction program and help avoid bringing in packaging material that will enter the company waste stream. A Canadian car manufacturer was able to eliminate 1,000 tons of waste and save more than \$2 million over the course of a five-year program by replacing original expendable containers for car parts with reusable shipping containers.⁸¹

⁸⁰Anonymous, "Follow a Leader to Recycle Mixed Paper," *Modern Office Technology*, Volume 36, Issue 9, September 1991, p. 26.

⁸¹ *Reaching for Solutions*. Toronto, Ontario, Canada: The Packaging Association of Canada, 1991, p. 11.

Returnable plastic containers are becoming more prominent as they are being used more frequently in just-in-time operations. These containers provide a significant cost saving. They also improve product handling and reduce product damage and theft, and they can improve automation capabilities. The use of reusable plastic containers can be seen as an attempt to curb the ecology and landfill problems in the United States resulting from the use of disposable packaging. The automobile industry is a leading proponent in developing just-in-time programs that use returnable plastic containers in connection with its parts suppliers.⁸²

Creating a Corporate Environmental Policy

A policy for solid waste reduction will be a part of a corporate environmental policy. The following provides a description of how a midwest utility created a corporate environmental policy. In October 1990, PSI Energy became the first utility in the Midwest to adopt an environmental charter at the board level. Crafted with the assistance of an environmental advisory council, the charter fundamentally changed the way PSI makes decisions and conducts business.⁸³

⁸²Torok, Douglas B. "Returnable Containers for JIT Handling," *Material Handling Engineering*, Volume 44, Issue 11, November 1989, pp. 48-51.

⁸³Rogers, James E., "Adopting and Implementing a Corporate Environmental Charter," *Business Horizons*, March-April 1992, p. 29.

The first draft of PSI's environmental charter was written by the special assistant on environmental issues and the director of environmental affairs in the Department of Rates and Regulatory Affairs. The draft then went through an internal review of comments, questions, and objections from top management representing all the company's major departments.⁸⁴ PSI chose to create an environmental advisory council comprised of members representing business, labor, government, education, and the environmental movement to provide guidance in reaching environmental decisions.⁸⁵

The most obvious change to the PSI organization was the creation of a Department of Environmental Stewardship independent of any existing function that reported directly to the executive vice president.⁸⁶ It also created an Environmental Stewardship Coordinating Council representing Power Operations, Customer Operations, and Environmental Programs, serving as an in-house advisory council to the Department of Environmental Stewardship.⁸⁷ In the first year, Environmental Stewardship focused much of its attention on activities to reduce, reuse, and recycle. The idea of reducing solid waste first caught the attention of employees in 1990 when they discovered that PSI used 31,000 throw-away cups each month. To reduce the unneeded waste, PSI gave every employee a reus-

⁸⁴Rogers, *Op cit.* p. 30.

⁸⁵*Ibid.*

⁸⁶Rogers, *Op cit.* p. 31.

⁸⁷Rogers, *Op. cit.*, p. 32.

able mug.⁸⁸ PSI also set up a new subsidiary, PSI Recycling, to separate and recover scrap cable and wire and well as handle recyclable paper.⁸⁹

PSI reports that through the process by which the charter was created and adopted, environmental ethics became an integral part of corporate culture. "The charter accomplished this by bringing environmental issues into the normal decision making process; policymakers did not have to 'go back to square one' to develop and defend a rationale for environmentally responsible action each time they faced a new issue." The environmental charter does not provide a clear-cut decision rule. It serves as a reminder to include environmental considerations in the decision making process.⁹⁰

Corporate Examples of Solid Waste Reduction Efforts

Implementation of a corporate solid waste policy as a part of an environmental policy may take many forms. Minnesota Mining and Manufacturing can date its environmental awareness back to the early 1970s.⁹¹ In 1975, Minnesota Mining and Manufacturing's corporate management devised an environmental policy statement, consisting of

⁸⁸Rogers, *Op. cit.*, p. 31.

⁸⁹*Ibid.*, p. 31.

⁹⁰Rogers, *Op. cit.*, p. 33.

⁹¹Gold, Jackey, " The Pioneers: 3M and H. B. Fuller Have Taken the Lead in Learning How to Make Pollution Control Equal Cost Control," *Financial World* Volume 159, Issue 2, January 23, 1990, pp. 56-58.

certain guidelines including preventing pollution wherever possible, developing products that affect the environment, and assisting government agencies engaged in environmental activities.⁹² The program was primarily directed at technical employees in manufacturing. Those who believed they had a worthwhile accomplishment were asked to submit their effort to a coordinating committee. Annual management reviews note which divisions make the most and the least contribution.⁹³ Over the first fifteen years, the program saved \$482 million worldwide and eliminated approximately 527,300 tons of air, water, sludge, and solid waste pollutants from the production processes.⁹⁴

Chevron established a program in 1987 called SMART, for Save Money and Reduce Toxics.⁹⁵ In its first year, SMART employed source reduction, recycling, and treatment technologies to cut the volume of waste requiring disposal by some 44 percent from 135,000 tons to 76,000 tons. SMART saved the company \$3.8 million in the process.⁹⁶

⁹²Anonymous "Why Pollution Prevention Pays at 3M," *Industrial Management*, Volume 11, Issue 4, May 1987, pp. 24-26.

⁹³*Ibid.*

⁹⁴Gold, *Op. cit.*

⁹⁵Porter, J. Winston, and Jonathan Z. Cannon, "Waste Minimization: Challenge for American Industry," *Business Horizons*, March-April 1992, p.48.

⁹⁶Porter, *Op. cit.*, pp. 48-49.

Dow Chemical calls its minimization program WRAP, for Waste Reduction Always Pays. The company initiated more than 40 new projects in 1988 and 1989, which cut its solid waste streams by 44,000 tons each year.⁹⁷

Summary

The modern environmental movement has matured since the 1960s, pervading through federal, state, and local legislative dockets, domestic and international markets, and achieving increased emphasis in corporate decisions. Rising disposal costs, legislative uncertainty, and the desired to be perceived as a good corporate citizen have increased the likelihood corporations will address solid waste reduction.

The next section will provide a framework explaining the evolution of purchasing operations and identify the role of purchasing in solid waste management activities.

Linking Purchasing Operations to Corporate Solid Waste Reduction Efforts

Introduction

Corporations with a solid waste reduction policy, whether formal or informal, must integrate the policy into day-to-day operations. Hutchinson recommends functional areas start with purchasing to respond to the

⁹⁷Porter, *Op. cit.*, p.49.

corporate environmental challenge.⁹⁸ Purchased materials account for a significant percentage of total production cost, averaging approximately 55 percent of the total production costs⁹⁹ suggesting the purchasing function should be one of the primary functions to integrate into a solid waste reduction effort to facilitate the avoidance and reduction of material entering the corporation that will ultimately become part of the company waste stream.

Evolution of Purchasing

Purchasing has evolved from a clerical support role to significantly contributing to management decisions.¹⁰⁰ The evolution of the field, shown in Table Eight, shows the development of skills and professionalism across time. Morgan suggests "strategic sourcing is now at the executive level and will force a cascading cross-functional endeavor down throughout the organization."¹⁰¹ People with traditional purchasing roles

⁹⁸Hutchinson, Coli, "Corporate Strategy and the Environment," *Long Range Planning*, Volume 25, August 1992, p.11.

⁹⁹U.S. Bureau of Census, *Annual Survey of Manufacturers*, (Washington, D.C.: U.S. Government Printing Office, 1985) General Statistics for Industry Groups, p. 8 and appendix; and J. Miller and A. Roth, *Report on the 1986 North American Manufacturing Futures Survey*, (Boston: Boston University, 1986).

¹⁰⁰Reichard, Robert S., Risk Management: A Purchasing Tool for the 21st Century," *Purchasing*, May 21, 1992, pp. 40-45.

¹⁰¹Morgan, James P., " Strategic Sourcing Rises to the Top," *Purchasing*, April 2, 1992, pp. 54-55.

Table 8
Purchasing Evolution¹⁰²

	Pre 1960s	1960s	1970s	1980s	1990s +
Criteria	Supply Price	Quality/value	Continuity competitive pricing	Profit Forecasting	Resource allocation Bottom line results
Primary Objectives	3-bid sourcing	Price/value procurement	Cost sensitivity planning budgeting	Trading profit contribution	Risk Management
Image	Clerical support role	Emergence as peer among professionals	Integral part of management process	Senior executive status ontributing to profits	Mover and shaker Contributor to management decisions

¹⁰² Reichard, Robert S., Risk Management: A Purchasing Tool for the 21st Century," *Purchasing*, May 21, 1992, p. 41.

will have to integrate solid waste reduction sourcing strategy into transactions with external suppliers.¹⁰³

Much of the current literature treats purchasing strategy and policy from the perspective of narrowly defined operating level policies and strategies.¹⁰⁴ More recent writings have begun to recognize the importance of purchasing in formulating corporate level strategies.¹⁰⁵

Reck and Long propose a four-stage model of purchasing's strategic contribution to corporate competitiveness.¹⁰⁶ They suggest that a typical purchasing organization moves through four developmental stages; passive, independent, supportive, and integrative and that the purchasing organizations most likely to be involved in integrating a solid waste reduction policy will be in the latter stages of development.

¹⁰³*Ibid.*

¹⁰⁴Watts, Charles A., Kee Young Kim, and Hahn, K. Chan, "Linking Purchasing to Corporate Competitive Strategy," *International Journal of Purchasing and Materials Management*, Fall 1992, p.3.

¹⁰⁵Op. cit., p.2.

¹⁰⁶Reck, Robert F. and Brian G. Long, "Purchasing: A Competitive Weapon," *Journal of Purchasing and Materials Management*, Volume 24, Number 3, Fall 1988.

Freeman and Cavinato propose a four-stage model for fitting purchasing to the strategic objectives of the firm.¹⁰⁷ Their model is based on the previously developed four stages of strategic development processes; financial planning, forecast-based planning, externally oriented planning, and strategic management. Using these stages, they identify and describe the purchasing characteristics necessary in each stage.¹⁰⁸

Monczka and Trent emphasize that purchasing strategy must foremost support a firm's competitive position.¹⁰⁹

Purchasing's Role in Implementing Solid Waste Reduction Policy

Watts, Kim, and Chan link purchasing into integrating the corporate strategy by acting in a boundary spanning role linking manufacturing and corporate strategies with supplier's capabilities externally.¹¹⁰ They define purchasing strategy as the "pattern of decisions related to acquiring required materials and services to support operations activities that are consistent with the overall corporate competitive strategy"¹¹¹ suggesting

¹⁰⁷Freeman, Virginia T. and Joseph L. Cavinato, "Fitting Purchasing to the Strategic Firm: Frameworks, Processes, and Values," *Journal of Purchasing and Materials Management*, Volume 26, Number 1, Winter 1990.

¹⁰⁸Watts, et. al., *Op. cit.*, p. 5-7.

¹⁰⁹Monczka, Robert M. and Robert J. Trent, *International Journal of Purchasing and Materials Management*, Fall 1992, pp. 9-19.

¹¹⁰Watts, et. al., *Op. cit.*, p.2.

¹¹¹Watts, et. al., *Op. cit.*, p.5.

the boundary spanning role of purchasing is a key competency which purchasing may offer to integrate a corporate solid waste policy.

Roy and Whelan suggest taking greater responsibility for their products has led manufacturers to the broader concept of "product stewardship."¹¹² Because most firms are not involved in all phases of the life of a product, cooperation among the various companies in the product's value chain becomes essential to develop a strategy for solid waste reduction. They conclude the organization most likely to facilitate cooperation across the value chain is the purchasing function.¹¹³

Changing Skill Requirements

Environmental departments at plant sites used to consist of one person and that person usually ran the department on a part-time basis while holding down a regular staff assignment.¹¹⁴ Manufacturers are realizing that properly trained, environmentally aware employees are the key to making day-to-day decisions,¹¹⁵ suggesting implementation and maintenance of a solid waste reduction policy requires additional training of purchasing personnel.

¹¹²Whelan, *Op. cit.*, p. 70.

¹¹³*Ibid.*

¹¹⁴*Ibid.* p. 43.

¹¹⁵Marshall, M. E. and David W. Mayer, "Environmental Training: It's Good Business," *Business Horizons*, March-April 1992, p. 54.

Technological improvements have enhanced the ability of companies to manage their solid waste stream. New materials, product design considerations, and the use of information technology offer great potential to help resolve many of the environmental issues.

Various computer programs and models are becoming available that are designed to provide realistic information about the actual composition of the solid waste stream. Kline and Company's Lotus 1-2-3 computer model, called Recycle, can help packaging suppliers demonstrate to legislative and regulatory bodies just what happens to various forms of packaging in the typical municipal solid waste stream. It traces the various forms of packaging to their ultimate disposal and shows their affect, for example, on recovered and disposal costs.¹¹⁶ Johnson & Johnson developed personal computer software called PackTrack™ to track packaging source reduction. The software can be used for modeling activities, and create reporting documents using the Coalition of Northeastern Governors Preferred Packaging Report format.¹¹⁷ Stewart Mosberg of Packaging Coalition for Solid Waste Management has developed an extensive cross-referenced database on packaging and solid waste.¹¹⁸ George Peters of the Ohio Department of Natural Resources reports some states are now

¹¹⁶Larson, Melissa "Analyzing Solid Waste," *Packaging*, Volume 34, Issue 11, August 1989, pp. 8-10.

¹¹⁷Information from documentation accompanying PackTrack™ software received from Mr. Randolph T. Haviland, Johnson & Johnson Company.

¹¹⁸*Ibid.*

creating electronic "swap" bulletin boards to facilitate the exchange of solid waste materials between companies. Waste by-product from one company may be a processing material for another company. The electronic bulletin boards are used to match supply and demand for material that otherwise would enter the solid waste stream.¹¹⁹

The literature does not provide an indication of how purchasing has been affected by the integration of a solid waste policy. Only one example was found of the integrating a corporate environmental strategy into the purchasing process. Hewlett-Packard added an environmental metric to their measurement of supplier performance. Their purchasing criterion for measuring suppliers now includes technology, quality, responsiveness, delivery, cost, and environment.¹²⁰ While corporations and their purchasing operations are already involved in some solid waste reduction activities, the true integration of the solid waste policy throughout purchasing practices will continue to evolve. If purchasing involvement best facilitates an effective and efficient implementation of a corporate solid waste reduction policy, what should be the role of purchasing? Further information is needed to determine how the integration has affected the purchasing organization in terms of changing skills, modified functional relationships, and organization structure.

¹¹⁹Peters, George, personal interview, Education and Research Manager, Division of Litter Prevention and Recycling, Ohio Department of Natural Resources, May 3, 1991.

¹²⁰Anonymous, "1992 Medal of Excellence," *Purchasing*, September 24, 1992, p. 39.

Summary

The reduction of solid waste requires cooperation among the various companies in the product's supply chain. The purchasing function provides a boundary spanning role linking manufacturing and corporate strategies with supplier capabilities and is best positioned to facilitate cooperation between all parties.

The next section will identify current information regarding how corporate environmental activities affect purchasing operations and will identify the gaps in the literature which will be addressed by this study.

Present Environmental Involvement of Purchasing

This section reviews how environmental awareness has extended through the purchasing organization to become a consideration in customer and supplier relationships. It also cites a recent survey that indicates environmental involvement by the purchasing organization occurred in the majority of companies surveyed.

A 1992 *Purchasing* survey of buying responsibilities among the top one hundred purchasing organizations in the United States found 65% with some form of environmental, hazardous waste treatment, or source reduction duties.¹²¹ Many buyers have begun to specify reusable, returnable

¹²¹ Stundza, Tom, "You and the Environment," *Purchasing*, Volume 112, Issue 7, April 16, 1992, pp. 49-53 .

containers, to purchase recycled paperboard products, and to work with engineering to reduce the amount of packing materials in final-product shipping containers.¹²²

In a 1991 *Purchasing World* reader survey,¹²³ eighty-seven percent of the respondents reported that their companies collect used or excess materials for recycling. Sixty-eight percent indicated that the purchasing and materials management functions were involved in their company's recycling program. Paper and metals were the two items collected most. Only about half of the respondents' companies bought recycled or scrap material for use in their own operations, of these, 76% purchased recycled paper. For fifty-one percent of the respondents' companies, recycled materials offered a price savings, and 65% considered those materials' quality the same as that of virgin materials. Twenty-eight percent of those that bought recycled material believed that it was more expensive than virgin material. Over half of the respondents' companies actively seek out and support suppliers that have stated a commitment to environmental programs suggesting environmental awareness has extended into the relationships between customer and supplier.

¹²²*Ibid.*

¹²³Webb, Nan, " Recycling Tasks Are Part of the Job," *Purchasing World*, Volume 35 Issue 3, March 1991, pp. 42-43.

Packaging Redesign

An effective solid waste reduction program may include re-assessing the packaging of the product. Improved packaging design, lightweighting and alternative materials and consideration of distribution requirements across the entire packaging life offer potential for improvements to support a corporate solid waste reduction effort.

A positive sign for packaging buyers is the increasing number of new and innovative products on the market, with the accent on lower overall cost, lighter weight, more strength, potential for recycling, and less bulk. For example, in the paper area, stronger corrugated containers are now on the market that reportedly have 25% more stacking strength than the typical carton.¹²⁴

Packaging experts recommend that shrink wrap offers at least equal protection at a lower cost than corrugated cardboard. What is more important, shrink wrap allows freight handlers to see the items they are handling, encouraging them to handle the products with greater care. Ettore suggests better design of packages with distribution requirements in mind would lead to greater cube utilization during truck loading.¹²⁵

¹²⁴Anonymous, "Packaging Outlook: Availability at Good Prices," *Purchasing World*, Volume 34, Issue 4, April 1990, pp. 40-42.

¹²⁵Ettore, John J. "Packaging Opening Up," *Transportation and Distribution*, Volume 28, Issue 13, December 1987, pp. 18-21.

Re-designing packaging material can reduce material and transportation cost, The purchasing organization may take an active role in the reduction of packaging material sent to a customer as a means of reducing costs. Likewise, the purchasing organization may work with suppliers to reduce the amount of packaging material received into the company solid waste stream. Investigation of purchasing's involvement in packaging reduction efforts may offer additional insights to changing customer and supplier relationships as they integrate environmental policy.

Summary

The *Purchasing* surveys suggest environmental awareness has extended into the relationships between customer and supplier and is a part of purchasing activities. The surveys suggest buyers are becoming more involved in designating packaging materials and working with suppliers to redesign packaging materials. Buyers are faced with an increasing number of new products on the market offering lower overall cost, lighter weight, more strength, less bulk, and potential for recycling.

The literature does not indicate what role purchasing should have in corporate solid waste reduction activities or how the purchasing organization is affected by its involvement. It does not identify how environmental awareness has and will modify customer and supplier relationships, affect the time and complexity of the sourcing decision, or influenced the "buy" decision. It does not address how solid waste reduction goals are set and subsequently measured.

Conclusion

This chapter provided an overview of the evolution of solid waste management, both in the United States, and internationally. It identified key components and issues of the solid waste stream, explored governmental and industrial efforts to manage the solid waste stream, provided a framework supporting why a corporation should manage their solid waste stream and explored current information regarding how corporate environmental activities affect purchasing operations. It identified the trend that environmental awareness has increasingly been incorporated into corporate strategic planning.

As environmental awareness grows, it is likely purchasing activities will further reflect the environmental awareness and solid waste management efforts of the corporation. There is little information regarding how these efforts have affected purchasing operations or the degree to which these efforts are changing.

Purchasing is evolving from a clerical support role to become a contributor of management decisions. Additional duties such as the integration of a solid waste management policy may help purchasing become more visible to top management. If purchasing involvement best facilitates an effective and efficient implementation of corporate environmental policy, what should be the role of purchasing? Further information is needed to determine how corporate solid waste reduction efforts the integration have and will affect the purchasing organization in terms of

changing skills, modified functional relationships, and organization structure. The following research will address these gaps in the literature.

CHAPTER III RESEARCH DESIGN

Introduction

The steps in the research process used to carry out the study are developed and explained in this chapter. The research questions and hypotheses are developed in detail. The survey questionnaire is explored in detail. The purpose of each question is discussed as is its relationship to other questions. The method of testing each question is also explained. Criteria for selecting members of the survey sample are reviewed. The case study interview protocol is developed and explained and, stages of the project are outlined and related to the overall project objectives.

The research investigates how corporate solid waste management efforts affect purchasing operations, both internally and throughout the supply chain. The study identifies changes between 1990 and 1993 and projected changes between 1993 and 1996. The independent variable is a solid waste management effort by a company or channel member. The dependent variables, those variables presumed affected by the independent variable include changes to packaging by weight and by volume, types of packaging materials used, changes to organization, required skills, sourcing lead-time, and sourcing complexity. The research analyzes how each

of these has changed as a result of corporate or channel solid waste management efforts.

The research involved a two-stage methodology. The first stage was a mail survey used to determine how corporate solid waste management efforts of packaging material have affected purchasing and to develop the basis for projecting how the solid waste management efforts of packaging material will affect purchasing in the next three years. The second stage is a field case study used to examine approaches to the implementation and maintenance of solid waste management efforts of packaging material within case study companies and throughout the supply chain.

Research Hypotheses

Review of the current literature suggests environmental awareness is becoming a part of the corporate strategy for commercial and industrial firms. The current literature does not provide sufficient information on how to integrate the strategy throughout the organization nor does it indicate the effect solid waste management efforts have had on specific functional areas such as purchasing. The primary research questions identified in Table Nine were developed to investigate how corporate solid waste management efforts have affected purchasing. The primary research questions cover changes from 1990 to 1993 and projected changes from 1993 to 1996 for organizational structure and functional interaction within the firm and between customers and suppliers.

Table 9
Primary Research Questions

	Internal Changes	External Changes
Past 1990 - 1993	<p>Research Question #1:</p> <p>How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation within the company?</p>	<p>Research Question #3:</p> <p>How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation throughout the supply chain?</p>
Future 1993 - 1996	<p>Research Question #2:</p> <p>How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation within the company?</p>	<p>Research Question #4:</p> <p>How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation throughout the supply chain?</p>

Table 10
Research Question 1

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation within the company?

- H1.1:** There are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and 1993.
- H1.2:** There are no differences in the skills required by purchasing to support packaging solid waste management efforts in 1990 and 1993.
- H1.3:** There are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993
- H1.4:** There are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.
- H1.5:** There are no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.
-

Table 11
Research Question 2

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation within the company?

- H2.1:** There will be no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1993 and 1996.
- H2.2:** There will be no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1993 and 1996.
- H2.3:** There will be no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.
- H2.4:** There will be no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.
-

Each research question was analyzed by testing several hypotheses. The first research question considers how efforts to reduce packaging solid waste have influenced purchasing practices within the company from 1990 to 1993. The second research question considers how efforts to reduce packaging solid waste will change purchasing practices within the company from 1993 to 1996. It should be noted that both research questions in Table Ten and Table Eleven consider how corporate solid waste management of packaging has influenced purchasing practices within the company.

Hypothesis 1.1 is that there are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and in 1993. These changes may include management accountability, modifying the mission of a department, creating a special department, a special job assignment, or modifying the job scope of buyers. Hypothesis 2.1 is that there will be no differences in the organizational structure between 1993 and 1996.

Hypothesis 1.2 is that there are no differences in the skills required by purchasing to support packaging solid waste management efforts in 1990 and 1993. Management of solid waste may require special or unique procurement skills to help address the waste management issues such as understanding the current and pending solid waste legislation as it affects the company, awareness of legal obligations, expanded knowledge of the packaging material life cycle, and options in packaging materials and design. Many of these skills involve the awareness and understanding that is precursory to implementation of solid waste management efforts.

Table 12
Research Question 3

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation throughout the supply chain?

- H3.1:** There are no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
- H3.2:** There are no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
- H3.3:** There are no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
- H3.4:** There are no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
- H3.5:** There are no differences in the type of packaging material used in 1990 and 1993.
- H3.6:** There are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993.
-

Table 13
Research Question 4

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation throughout the supply chain?

- H4.1: There will be no differences in the weight per unit of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
- H4.2: There will be no differences in the volume per unit of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
- H4.3: There will be no differences in the weight per unit of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
- H4.4: There will be no differences in the volume per unit of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
- H4.5: There will be no differences in the type of packaging material used in 1993 and 1996.
- H4.6: There will be no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1993 and 1996.
-

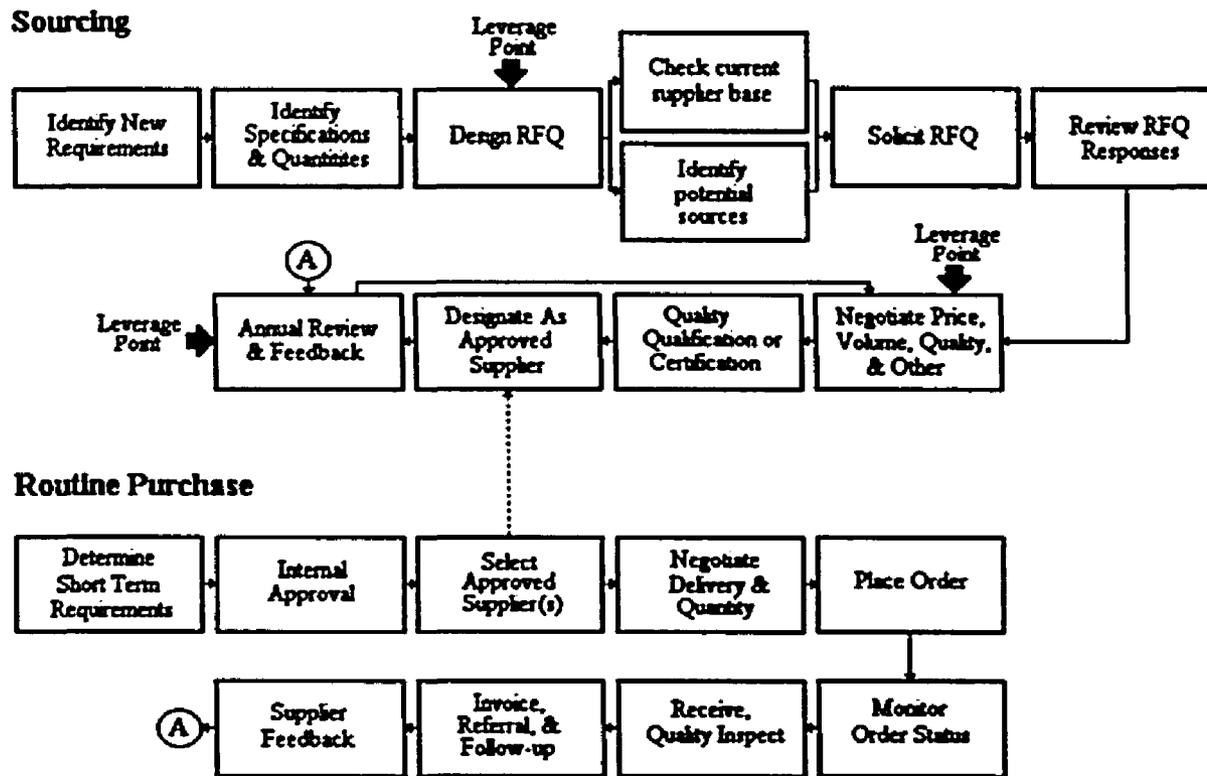


Figure 5

Simplified Sourcing and Routine Purchasing Process

It is assumed that any special or unique skills will have already been identified for the current or projected issues, subsequently, there is no corollary hypothesis projecting future skill requirements by 1996.

Hypothesis 1.3 is that there are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993. The literature suggests environmental awareness is now a part of corporate decision making. If solid waste management has been integrated, the purchasing "buy" decision should reflect consideration of factors to reduce the amount of packaging and other material entering the company that will ultimately enter the corporate solid waste stream. Hypothesis 2.2 is that there will be no differences in influences on the "buy" decision in 1993 and 1996.

The sourcing decision acts as a filter to reduce the number of potential suppliers from which the company will purchase items. A simplified sourcing and routine purchasing process is shown in Figure Five. The leverage points identify those segments of the overall process where solid waste management efforts will most likely be integrated into the "buy" decision. The leverage occurs at the initial point of design of the Request For Quotation before it is sent to prospective suppliers, at the point of negotiation of terms and conditions with the prospective supplier, and during the annual review and feedback with current suppliers. Any attempt to modify terms and conditions of activities with a supplier, such as could be found with solid waste management efforts, would potentially endanger a contractual agreement. The most likely leverage points therefore are located where the terms and conditions are determined or

renegotiated with suppliers. Solid waste management efforts add another parameter to the sourcing decision that may add to the sourcing lead-time or complexity of the sourcing decision. Hypothesis 1.4 is that there are no differences in the time it takes to make a sourcing decision which supports solid waste management efforts and a sourcing decision which does not support solid waste management efforts. Hypothesis 1.5 is that there are no differences in the complexity of a sourcing decision which supports solid waste management efforts and a sourcing decision which does not support solid waste management efforts.

Hypothesis 2.3 is that there will be no differences in the time to make a sourcing decision in 1993 and 1996. Hypothesis 1.5 is that there are no differences in the complexity of a sourcing decision which supports solid waste management efforts and a sourcing decision which does not support solid waste management efforts. Hypothesis 2.4 is that there will be no differences in the complexity of sourcing decisions in 1993 and 1996.

The third research question considers how solid waste management efforts influenced purchasing practices between customers and suppliers from 1990 to 1993. The fourth research question considers how solid waste management efforts will change purchasing practices between customers and suppliers from 1993 to 1996. It should be noted that both research questions in Table Twelve and Table Thirteen consider how corporate solid waste management of packaging has influenced purchasing practices outside the company in the supply channel.

Solid waste management efforts should influence changes to the weight and volume of packaging material sent to customers and received from suppliers. Hypotheses 3.1 through 3.4 are that there are no differences in the weight and volume of inbound and outbound packaging, respectively, in 1990 and 1993. Hypotheses 4.1 through 4.4 are that there will be no differences in the weight and volume of inbound and outbound packaging, respectively, in 1993 and 1996.

Companies may utilize alternative packaging materials as a means of reducing the weight or volume of packaging material. The utilization of reusable packaging may also be used to reduce the amount of packaging material entering the corporate solid waste stream. Hypothesis 3.5 is that there are no differences in the packaging material used in 1990 and 1993. Hypothesis 4.5 is that there will be no differences in the packaging material used in 1993 and 1996.

Relationships between companies may be modified due to solid waste management efforts by a customer or a supplier. The relationship may stay at arm's length or develop toward closer working relationship such as increasing the amount of information shared or working jointly on a development project. Hypothesis 3.6 is that there will be no differences in the purchasing relationships between customers and suppliers due to solid waste management of packaging material in 1990 and 1993. Hypothesis 4.6 is that there will be no differences to purchasing relationships in 1993 and 1996 as a result of solid waste management of packaging material.

Methodology

The research involves a two-stage methodology. The first stage is a mail survey used to determine how corporate solid waste management efforts of packaging material have affected purchasing and projecting how the solid waste management efforts of packaging material will affect purchasing in the next three years. The second stage is a series of case studies utilizing the original survey questions plus additional questions generated from the analysis of the survey to look for common threads in the implementation and maintenance of solid waste management efforts of packaging material within case study companies and throughout the supply chain.

Stage One: Survey

The research data was collected through a mail questionnaire. The research instrument was pre-tested through faculty review and six personal industry interviews for content validity, ease of understanding of the content, and willingness and ability of the executives to respond to the questions.

Survey Design and Pre-Test

Survey questions were initially developed by identifying potential changes to the business process and relationships as a result of a solid waste reduction effort. The researcher utilized his industry experience to consider how one would implement a solid waste management effort. For

example, if a supplier was requested to reduce the amount of packaging material used, how would this impact the buyer-seller relationship? If purchasing were to take a lead role in solid waste management, how would this effort be integrated into the purchasing process? How would the effort be tracked and measured? Were there alternatives to current packaging? Each issue generated a number of possible questions that could be asked. The questions were grouped together by topic and an a priori answer was created for each question. The a priori answers helped suggest potential ways how the questions would be answered which in turn helped identify how each question should solicit an answer.

Each question was reworked; question wording and instructions were simplified with the help of faculty review. A five point Likert scale was selected for questions seeking the respondent's opinions. The five point scale allows for the extremes of "Strongly Agree" and "Strongly Disagree," a neutral position, and a position between each extreme and a neutral position. A smaller scale using "Agree," "Neutral," or "Disagree" was ruled out as the researcher was concerned respondents would be as likely to take a position as they would with a five point Likert scale. The researcher felt use of a larger Likert scale would do just the contrary and unnecessarily dilute the strength of the respondent opinion.

Each question was modified to make the questionnaire as efficient as possible and simplify the amount of effort and time required of the respondent. Questions seeking quantitative answers were kept to a minimum and were validated through each of the industry pre-test interviews to ensure the question was reasonable and understandable.

The survey questions were arranged to place the easiest responses, using the Likert scale questions, first in order to encourage completion of the survey. The question most likely to have respondents "disqualify" themselves from the survey was placed at the end of the survey, asking the respondent if they had an "on-going solid waste reduction effort." Earlier placement of this question likely would have the undesirable effect of reducing the response rate, particularly from companies without a solid waste reduction effort.

The size of the survey was reduced from eight word processed pages down to four pages by eliminating redundant questions, rewording, and combining questions. Type fonts were reduced and margins were extended to allow the survey to fit on four pages. These changes were included in the industry pre-test to check for readability. The final survey instrument was printed on 11" X 17" paper and folded in half to make an 8 1/2" X 11" document.

Pre-test of the survey questionnaire was conducted by personally interviewing the following industrial executives:

1. Mr. Paul Jenks - General Manager, Waste Management, Inc.,
Columbus, Ohio
2. Mr. Walt English - Purchasing Manager, Ross Laboratories,
Columbus, Ohio

3. Mr. Dallas Mulder, Vice President of Physical Distribution, The Limited, Columbus, Ohio
4. Mr. Bruce Burns - Director of Operator Services, Cincinnati Bell Telephone, Cincinnati, Ohio

In addition, the initial survey design was reviewed by Mr. Dennis Colard, Corporate Logistics Manager of the Hewlett-Packard Corporation, Palo Alto, California, and Mr. Jack Yost, Purchasing, City of Columbus. The participants represented a variety of industries and executive positions. There were no significant differences in the interpretation of the survey questions. The benefit of conducting the survey pre-test was to improve the wording and flow of the questions, and validate that the questions were reasonable.

Survey Group

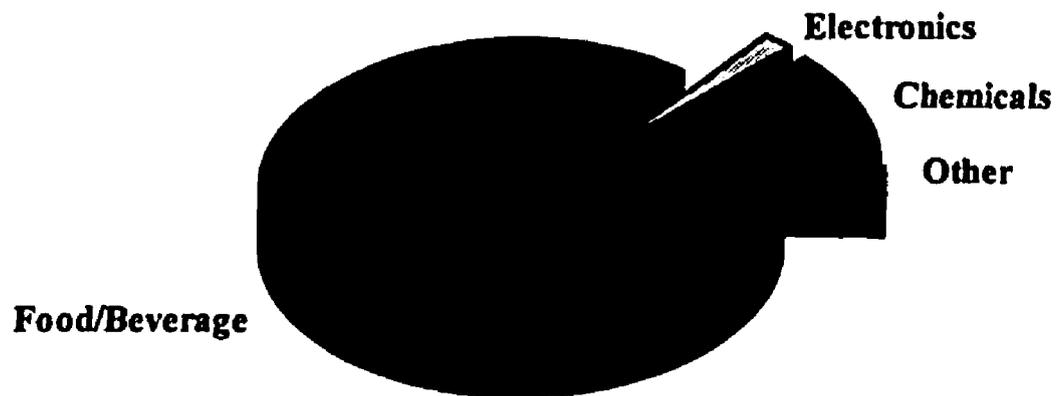
The source of survey participants was a subset of the membership list of the National Association of Purchasing Management. The National Association of Purchasing Management is a professional organization of over 39,000 purchasing professionals organized to promote professionalism in the field across all industries and including companies and organizations of all sizes. The National Association of Purchasing Management supports the Center for Advanced Purchasing Studies at Arizona State University. The National Association of Purchasing Management partially supported this research through its doctoral dissertation grant program. The Center for Advanced Purchasing Studies provided a membership listing of 2,904 mailing labels of purchasing directors and

vice presidents from their membership under the condition the researcher would keep the sample confidential and would consider submitting an article on the research to the *Journal of Purchasing and Materials Management*.

The target survey group for the research was industries that are high volume users of packaging material. *Packaging Magazine* annually ranks the top 100 domestic consumers of packaging material and containers. In 1991, the list of companies accounted for 41.7% of all packaging material consumed in the United States. Figure Six and Table Fourteen show the food and beverage industry is the greatest consumer of packaging material and containers, followed by the chemical and electrical/electronic industries. Companies in these industries comprise 98.5% of the packaging expenditures by the top 100 companies.¹²⁶

A subset of 480 names was created from the 2,904 names received from the National Association of Purchasing Management. The subset included only purchasing directors and vice presidents from the target industries; 176 names from the chemical and allied chemical products industries, 158 names from the electrical and electronic industries, and 146 names from the food and beverage industries.

¹²⁶*Packaging*, July 1992, pp. 24 - 30.



Primary Industry	Total Purchases
Food/Beverage	85.0%
Chemicals	11.8%
Electronics	1.7%
Other	1.5%

Note: The top 100 purchasers of packaging material accounted for 41.7% of all packaging material purchased in the United States in 1991.

Figure 6

Top 100 Purchasers of Packaging Material in 1991¹²⁷

¹²⁷Derived from *Packaging*, July 1992, pp. 24 - 30.

Table 14

The Top 100 Domestic Consumers of Packaging Material and Containers¹²⁸

Rank	Company	Packaging Expenditures (\$ Millions)	SIC Industry Code*
1	Philip Morris	2,631.50	F
2	Anheuser-Busch	2,510.00	F
3	PepsiCo	1,646.50	F
4	Procter & Gamble	1,608.00	F, C, O
5	Coca-Cola	1,320.00	F
6	ConAgra	1,315.00	F
7	Coca-Cola Enterprises	1,133.50	F
8	RJR Nabisco	1,032.00	F
9	Seagram	762.00	F
10	Unilever US	674.75	F, C
11	Sara Lee	610.75	F, C, O
12	Nestle USA	578.00	F, C
13	Adolph Coors	536.61	F, O
14	Brown-Forman	450.25	F, O
15	Eastman Kodak	437.00	C, E, O
16	Campbell Soup	405.00	F
17	Borden	404.05	F, C
18	American Home Products	402.27	F, C, E
19	Stroh Brewing	399.75	F
20	General Mills	391.04	F
21	Clorox	359.00	F, C, O
22	Cadbury Schweppes	355.00	F
23	Archer-Daniels-Midland	343.00	F
24	Grand Metropolitan	326.00	F
25	Rhone-Poulenc Rorer	317.48	C
26	G. Heileman Brewing	305.75	F
27	Whitman	302.50	F, E, O
28	Del Monte USA	297.50	F
29	Revlon	294.25	C
30	H. J. Heinz	275.00	F
31	John Labatt	266.85	F
32	Ocean Spray Cranberries	258.38	F

¹²⁸*Packaging*, July 1992, pp. 24 - 30 and *Packaging*, July 1991, pp. 26 - 27.

Table 14 (Continued)

Rank	Company	Packaging Expenditures (\$ Millions)	SIC Industry Code*
33	Kellogg	252.00	F
34	Quaker Oats	251.75	F
35	S.C. Johnson & Sons	249.00	C
36	Johnson & Johnson	247.00	C, E, O
37	Sherwin-Williams	237.00	C
38	Dean Foods	204.75	F
39	Warner-Lambert	193.25	F, C
40	Bristol-Myers-Squibb	191.00	F, C, E
41	American Cyanamid	190.93	F, C, E
42	Tyson Foods	186.08	F
43	Du Pont de Nemours	186.00	C, E, O
44	Geo. A. Hormel	185.12	F
45	Hershey Foods	184.68	F
46	Allied-Signal	178.75	E, O
47	Dow Chemical	172.00	C, O
48	CPC International	171.00	F
49	Colgate-Palmolive	170.00	F, C, O
50	Dr. Pepper/Seven-Up	169.13	F
51	Ralston-Purina	169.00	F, E
52	Dole Food	161.00	F
53	Avon Products	157.70	C
54	Dial	148.38	F, C
55	General Motors	142.00	O
56	Mars	141.00	F
57	Keebler	138.02	F
58	Iowa Beef Processors	137.17	F
59	3M	134.43	C, E, O
60	Pabst Brewing	132.50	F
61	Pet	127.00	F
62	American Brands	118.00	F, O
63	Exxon	115.85	C, O
64	Bayer USA	113.00	F, C, E, O
65	IBM	108.00	E
66	McCormick & Co.	106.13	F, O
67	Schering-Plough	105.50	C
68	Ford Motor	101.16	O
69	Universal Tobacco	98.25	F, C
70	Hoechst Celanese	96.00	C

Table 14 (Continued)

Rank	Company	Packaging Expenditures (\$ Millions)	SIC Industry Code*
71	Cosmair	94.62	C
72	Sunkist Growers	93.90	F
73	Pfizer	93.50	C
74	Gold Kist	91.06	F, C
75	General Electric	90.00	E, O
76	Chiquita Brands	89.13	F
77	Reckitt & Colman	89.00	F, C
78	Morton International	89.00	F, C, O
79	Chevron	88.25	C, O
80	Motorola	88.00	E, O
81	PPG Industries	87.02	C, O
82	Bausch & Lomb	85.25	C, E
83	Mobil	82.50	C, O
84	Tenneco	80.75	C, O
85	Central Soya	80.00	F, C
86	Merck	78.13	C, E
87	Baxter International	75.11	C, E, O
88	Gerber Products	72.30	F, O
89	Land O'Lakes	72.10	F, C
90	Texaco	68.50	C, O
91	Black & Decker	68.13	E, O
92	Monsanto	68.00	F, C, E, O
93	SmithKline Beecham	64.50	C
94	Alberto-Culver	63.34	F, C
95	Flowers Industries	61.49	F
96	Olin	61.05	C, O
97	Thorn Apple Valley	60.53	F
98	Levi Strauss	59.65	O
99	Amoco	58.00	O
100	Chrysler	56.13	O

* - SIC Industry Classifications by *Packaging Magazine* use the following codes:

- F - Food/Beverages may also include Tobacco
- E - Electronics includes electrical, electronics, and instruments
- C - Chemicals and allied products
- O - Other includes Textiles, Apparel, Paper, Petroleum, Rubber, Leather, Stone, Clay, and Glass, Primary Metals, Fabricated Metals, and Transportation

The mailing list was processed using the following steps:

1. Elimination of all companies not in the target industries
2. Elimination of duplications within companies. Retention of the most senior person's name as determined by title.

Survey Procedure

A pre-notification letter on Ohio State University letterhead was sent to the 480 names. The pre-notification letters were sent out in daily batches of approximately 100 units to facilitate timing of a follow-up telephone call. Each recipient was contacted by telephone approximately two or three days after projected receipt of the pre-notification letter. The recipient was asked to participate in a written survey. Those consenting were sent the survey, a pre-paid pre-addressed return envelope, and a cover letter from the National Association of Purchasing Management requesting the recipient complete the questionnaire. Copies of the pre-notification letter, survey cover letter from NAPM, and written questionnaire are included in Appendix B.

If an individual could not be directly contacted, a message was left for the individual to contact the researcher's voice mail telephone number to indicate if they would participate in the survey or if they did not want to participate. The voice mailbox contained a message reiterating the message left for the individual. Use of the researcher's voice mail likely reduced the amount of "telephone tag" and facilitated the receipt of each individual's response.

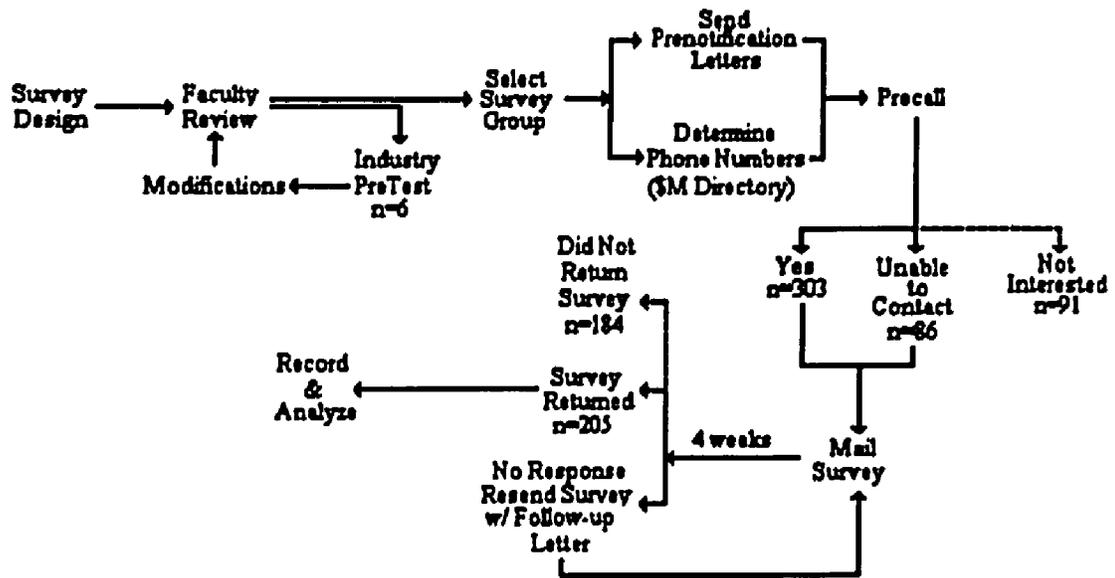


Figure 7

Survey Research Process

Approximately four days after the first message was left for the individual, a follow-up telephone call was made if the individual had not returned the call. After repeated attempts, the survey was sent to the individual with a note from the researcher located on the bottom of NAPM cover letter indicating the researcher was unable to contact the individual and requesting completion and return of the survey.

To attain a high rate of quality responses, the following key guidelines were used:

1. Pre-notification letters were sent to the executives under the signature of the dissertation advisor, Dr. Bernard J. LaLonde. The pre-notification letters were addressed to the individual company executive instead of the firm.
2. The pre-notification letters were not addressed using mailing labels. The letters were individually addressed using a laser printer and individually signed.
3. Pre-notification letters were printed on stationary and mailed in envelopes bearing the logo of The Ohio State University to allow the letter to stand out from routine business mail.
4. After receiving the pre-notification letter, the executive was personally contacted by telephone and asked for assistance to take ten minutes to fill out the questionnaire.

5. The questionnaire was mailed to the executive with a cover letter from the Executive Vice President of the National Association of Purchasing Management explaining who was conducting the research, identifying affiliation with The Ohio State University, and that the research was funded by NAPM.
6. The questionnaire was professionally printed using desk-top publishing.
7. A self-addressed pre-paid envelope was enclosed in each letter.
8. When a different person than was originally sent the survey returned it, the new person's name and title was noted. After a four week period, a cross reference between respondents and the original list was used to generate a follow-up mailing. The follow-up mailing was sent only to non-respondents.
9. Respondents were offered a copy of the results if they attached a business card or sent one under separate cover.

Each survey was numbered so the name and address of each participant could be associated with each returned survey. The tracking number was used to match responses with specific industries. The participant was assured, at the tracking number location on the survey, that the tracking

number was for classification purposes only and would not be utilized to publicly identify the respondent.

This survey procedure was patterned after a similar effort by McQuiston¹²⁹ in 1985. McQuiston surveyed purchasers of industrial scales and received 171 usable responses out of 273 surveys; a response rate of 62.6%. Purchasing personnel tend to be selective in the number and content of outside contacts allowed as a means of minimizing time-consuming "cold" sales calls. In many cases, corporate telephone directories will not release the telephone number of purchasing personnel. The pre-notification procedure was selected as a means to help circumvent the protective communication barriers put in place by purchasing personnel.

Sample Selection

The objective of this research was not to generalize to the overall population but to investigate the perceptions and actions of a selective group of purchasing executives. There were considerations of cost and time restrictions. A reasonable sample was readily available from a professional purchasing organization. The membership list from the National Association of Purchasing Management provided the initial judgment sampling. The scope of the survey required input regarding corporate strategic plans, identifying cross-functional relationships, and corporate relationships with customers and suppliers. To attain this information, the

¹²⁹McQuiston, Daniel H., "The Relative Participation of Functional Roles in the Industrial Decision Making Unit." unpublished dissertation, The Ohio State University, 1985.

survey needed to be sent to someone high enough in the corporation who had direct responsibility or accessibility to the information at a peer level yet would maintain a purchasing emphasis on the responses. Selection of the sample came from the National Association of Purchasing Management membership list of 39,000 names. Within the membership list are the names of 2,904 vice presidents and directors. The decision to survey representatives only from the food and beverage, chemical, and electronics industries; the highest volume consumers of packaging material and containers, further restricted the sample. The result was a final list of 480 purchasing vice presidents and directors. The resulting selection does not represent all industries, rather it reflects companies with memberships in the professional purchasing organization that are in the food and beverage, chemical, and electronics industries. It should be noted that the final sample included firms of all sizes from forty-six states¹³⁰ and two U.S. Territories.

The survey data has some measurement error due to the use subjective questions. Likert questions are used which seek respondent responses using a scale of "Strongly Agree," "Agree," "Neutral," "Disagree," and "Strongly Disagree." The scale used to answer the question is subject to the respondent's own perception of what is meant by "Strongly Agree" versus "Agree." Other questions ask the respondents to estimate the answer. Statistical treatment of these responses help factor out the measurement error.

¹³⁰Missing states were Hawaii, Maine, Montana, and North Dakota

Hypothesis Testing

The survey contained questions that gathered demographic information as well as questions to test the hypotheses. Question 22¹³¹ asked respondents to indicate their position or title and how long the respondent had been in the current position. Many of the survey questions asked the respondents to compare the prior three years to the present. The responses from participants with three or more years in their current position were compared with the responses from participants with less than three years in their current position. The mean score of each group was compared using a two sample t-test to determine if there was a significant difference between the responses.

Question 24¹³² asked respondents to indicate how procurement and solid waste were "primarily" managed in the corporation to determine if both operations were managed at the same level or were managed differently. The mean score of each group was compared using a two

¹³¹Survey Question #22:

What is your position or title?

How long have you held this position? _____

¹³²Survey Question #24:

How are each of the following primarily managed? (Please check one level only)

Procurement	Solid waste	
<input type="radio"/>	<input type="radio"/>	On a corporate level
<input type="radio"/>	<input type="radio"/>	On a local/divisional level
<input type="radio"/>	<input type="radio"/>	Both

sample t-test to determine if there was a significant difference in where the operation was managed.

Each survey had a tracking number.¹³³ The purpose of the tracking number was to allow the researcher to determine which names on the database had not answered the survey and should receive a second mailing of the survey. The tracking number also allowed the researcher to identify the industry of the respondents. Part of the analysis of the survey involved comparing responses to a question by industry. The use of the tracking number eliminated the need for a survey question asking the respondent to identify their industry.

Each hypothesis was tested with multiple survey questions as shown in Tables Fifteen through Eighteen.

Coding for Likert questions 1 through 12 assigned a "+2" for a response of "Strongly Agree," a "+1" for a response of "Agree," an "0" for a response of "Neutral," a "-1" for a response of "Disagree," and a "-2" for a response of "Strongly Disagree." Responses were grouped utilizing the response to question 23¹³⁴ that identified if the respondent's company had

¹³³Tracking number from the survey:

C 54	This number is used solely for tracking purposes. Confidentiality of your responses will be strictly maintained.
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¹³⁴Survey Question #23:

Does your company have a on-going solid waste reduction effort?

- Yes No

an "on-going solid waste reduction effort." The mean score of each group was compared using a two sample t-test to determine if there was a significant difference between the responses of companies with a solid waste management effort and companies without a solid waste management effort. If having a solid waste management effort significantly influenced the replies, further analysis was conducted using the responses to question 23a, b, and c¹³⁵ that further defined the solid waste management efforts.

The first research question considers how solid waste management efforts have influenced purchasing practices within the company. The second research question considers how solid waste management efforts will change purchasing practices within the company by 1996.

Hypothesis 1.1 is that there are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and 1993. Hypothesis 2.1 is that there will be no

135 Survey Questions #23a, #23b, #23c:

If the answer to the above question is YES, is your solid waste reduction effort:

- | Yes | No | |
|-----------------------|-----------------------|---|
| <input type="radio"/> | <input type="radio"/> | A formal, documented effort? |
| <input type="radio"/> | <input type="radio"/> | Shared with your suppliers? |
| <input type="radio"/> | <input type="radio"/> | Integrated within your procurement procedure? |

Table 15
Cross-Reference of
Hypotheses H_{1.1} through H_{1.5} and Questionnaire Items

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation within the company?

Hypothesis Stated	Questionnaire Item(s)
H _{1.1} : There are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and 1993.	17, 18
H _{1.2} : There are no differences in the skills required by purchasing to support packaging solid waste management efforts in 1990 and 1993.	6
H _{1.3} : There are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993.	1, 3, 4
H _{1.4} : There are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.	20
H _{1.5} : There are no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.	21

Table 16
Cross-Reference of
Hypotheses H2.1 through H2.4 and Questionnaire Items

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation within the company?

Hypothesis Stated	Questionnaire Item(s)
H2.1: There will be no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1993 and 1996.	17
H2.2: There will be no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1993 and 1996.	2, 5
H2.3: There will be no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.	20
H2.4: There will be no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.	21

Table 17

**Cross-Reference of
Hypotheses H_{3.1} through H_{3.6} and Questionnaire Items**

How have corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation throughout the supply chain?

Hypothesis Stated	Questionnaire Item(s)
H _{3.1} : There are no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.	14
H _{3.2} : There are no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.	14
H _{3.3} : There are no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.	14
H _{3.4} : There are no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.	14
H _{3.5} : There are no differences in the type of packaging material used in 1990 and 1993.	15, 16
H _{3.6} : There are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993.	9, 11, 19

Table 18
Cross-Reference of
Hypotheses H4.1 through H4.6 and Questionnaire Items

How will corporate purchasing practices with respect to packaging materials change in the next three years to respond to efforts to reduce solid waste generation throughout the supply chain?

Hypothesis Stated	Questionnaire Item(s)
H4.1: There will be no differences in the weight per unit of inbound packaging used in 1993 and 1996.	14
H4.2: There will be no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.	14
H4.3: There will be no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.	14
H4.4: There will be no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.	14
H4.5: There will be no differences in the type of packaging material used in 1993 and 1996.	13, 15, 16
H4.6: There will be no differences in the purchasing relationships between customers and suppliers due to solid waste management efforts in 1993 and 1996.	7, 8, 10, 12

Responses for question 17 were grouped by response to question 23 that identifies if the respondent's company has an "on-going solid waste reduction effort." A chi-square test was used to determine if there is a significant difference in the number of respondents who have made organizational changes with a solid waste management effort versus those without a solid waste management effort. Chi-square was used to allay concerns of a lack of a normal distribution. Further testing used information from question 23a, b, and c to further investigate the differences. Each chi-square test used $\alpha = .05$.

Descriptive statistics were also utilized to count and report the type of changes that have taken place or are projected to take place. Identical coding and analysis was used for the section of this question identifying changes by 1996 to test hypothesis 2.1.

Question 18¹³⁷ provides information regarding the job title of the procurement person primarily responsible for solid waste management efforts. Question 18 was not statistically tested but was compiled and used descriptive statistics to report which procurement employee is utilized to lead the solid waste management effort.

¹³⁷Survey Question #18:

What is the job title of the procurement person primarily responsible for solid waste reduction efforts? _____

Hypothesis 1.2 is that there are no differences in the skills required by purchasing to support solid waste management efforts in 1990 and 1993. Management of solid waste may require special or unique procurement skills to help address the waste management issues such as understanding the current and pending solid waste legislation as it affects the company, awareness of legal obligations, expanded knowledge of the packaging material life cycle, and options in packaging materials and design. Many of these skills involve the awareness and understanding that is precursory to implementation of solid waste management efforts. It was assumed that any special or unique skills will have already been identified for the current or projected issues, subsequently, there is no corollary hypothesis projecting future skill requirements by 1996. Question 6 was used to test hypothesis 1.2.

Question 6¹³⁸ identifies respondent attitudes regarding the need for special or unique procurement skills for solid waste management efforts. It utilizes a five-point Likert scale. The mean score of each group was compared using a two sample t-test to determine if a significant number of respondents who have experienced efforts to reduce solid waste feel special or unique skills are, or are not, required. The test was against the mean of each group being equal at $\alpha = .05$.

¹³⁸Survey Question #6:

Solid waste reduction requires special or unique procurement skills.

SA - A - N - D - SD

Hypothesis 1.3 is that there are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993. Hypothesis 2.2 is that there will be no differences in 1993 and 1996.

Questions 1 through 5¹³⁹ are used to test hypotheses 1.3 and 2.2. All these questions utilized the five-point Likert scale coding. The mean score of each group was compared using a two sample t-test to determine if a significant number of respondents who have experienced efforts to reduce solid waste feel solid waste management efforts influence the "buy" decision. The test was against the group means being equal utilizing $\alpha = .05$. In addition, a two sample t-test utilizing $\alpha = .05$ was used to de-

¹³⁹Survey Question #1:

In the last three years, there has been a significant change in how we consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

Survey Question #2:

In the next three years, I expect additional pressure to consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

Survey Question #3:

The amount of packaging material used by a supplier is considered when selecting a supplier.

SA - A - N - D - SD

Survey Question #4:

The amount of packaging material used by a supplier is more important now in the supplier selection process than it was in 1990.

SA - A - N - D - SD

Survey Question #5:

The amount of packaging material used by a supplier will be more important in 1996 in the supplier selection process than it is now.

SA - A - N - D - SD

termine if there is a significant difference between the responses of question 1 and question 2. If there is a significant difference and the mean of question 2 is greater than that of question 1, respondents are projecting corporate solid waste management will be more of a consideration in procurement decisions between 1993 and 1996 than it was between 1990 and 1993. Similar analysis was conducted comparing questions 4 and 5. If there is a significant difference between these questions and the mean of question 5 is greater than that of 4, respondents are projecting the amount of packaging material used by a supplier will be more important in the supplier selection process between 1993 and 1996 than it was between 1990 and 1993.

Hypothesis 1.4 is that there are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993. Hypothesis 2.3 is that there will be no differences in 1993 and 1996.

Question 20¹⁴⁰ was used to test hypotheses 1.4 and 2.3. Coding for this question assigned a "+1" for a response of "increased sourcing lead time," a "0" for a response of "not changed the sourcing lead time," and a "-1" for a response of "reduced the sourcing lead time." Responses were grouped utilizing the response to question 23 that identifies if the respondent's company has an "on-going solid waste reduction effort." A chi-square test using $\alpha = .05$ was conducted to determine if sourcing lead times were longer, shorter, or had remained the same as a result of solid waste reduction efforts. Descriptive statistics were also utilized to count and report changes in sourcing lead time.

Hypothesis 1.5 is that there are no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993. Hypothesis 2.4 is that there will be no differences in 1993 and 1996.

¹⁴⁰Survey Question #20:

Over the last three years, our solid waste reduction efforts have:

- increased sourcing lead time
- not changed the sourcing lead time
- reduced the sourcing lead time

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

Question 21¹⁴¹ was used to test hypotheses 1.5 and 2.4. Coding for this question assigned a "+1" for a response of "increased the complexity of sourcing," a "0" for a response of "not changed the complexity of sourcing," and a "-1" for a response of "reduced the complexity of sourcing." Responses were grouped utilizing the response to question 23 that identifies if the respondent's company has an "on-going solid waste reduction effort." A chi-square test using $\alpha = .05$ was conducted to determine if sourcing complexity is greater, less, or the same as a result of solid waste reduction efforts. Descriptive statistics were also utilized to count and report changes in sourcing complexity.

The third research question considers how solid waste management efforts have influenced purchasing practices between customers and suppliers. The fourth research question considers how solid waste management efforts will change purchasing practices between customers and suppliers by 1996.

141 Survey Question #21:

Over the last three years, our solid waste reduction efforts have:

- increased the complexity of sourcing
- not changed the complexity of sourcing
- reduced the complexity of sourcing

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

Hypotheses 3.1 and 3.2 are that there are no differences in the weight or volume of inbound primary, secondary, and tertiary packaging used in 1990 and 1993. Hypotheses 4.1 and 4.2 are that there will be no differences between 1993 and 1996. Hypotheses 3.3 and 3.4 are that there are no differences in the weight or volume of outbound primary, secondary, or tertiary packaging used in 1990 and 1993. Hypotheses 4.3 and 4.4 are that there will be no differences in 1993 and 1996.

Question 14¹⁴² was used to test hypotheses 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, and 4.4. Question 14 identifies packaging management efforts by weight and volume for changes that have taken place between 1990 and 1993 and projected changes between 1993 and 1996. The survey respondent provided percentage changes for each cell. The question was designed to allow the respondent to identify packaging changes by weight, by volume, or both. The question seeks greater definition by asking that the changes be identified by primary and secondary/tertiary packaging.

142Survey Question #14:

Please provide your best estimate of packaging reduction efforts by:

	Between 1990 & 1993		Between 1993 & 1996	
	By Weight	By Volume	By Weight	By Volume
Your Company				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%
Your Suppliers				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%

Descriptive statistics will be utilized to count and report what types of changes have taken place. The mean score of each group was compared using a two sample t-test to determine if there was a significant difference in the percentage of change made between 1990 and 1993 and the projected changes from 1993 to 1996. When there is a significant difference and the mean of the "projected" cell is greater than the mean of the "historical" cell, this suggests corporate solid waste management efforts will continue to develop and increase in the future.

Responses will also be grouped utilizing the response to question 23 that identifies if the respondent's company has a "formal, documented solid waste reduction effort." The mean score of each group was compared using a two sample t-test to determine if there is a significant difference in the changes by respondents who have a formal effort versus those without a formal effort. The test used $\alpha = .05$.

Hypothesis 3.5 is that there are no differences in the type of packaging materials used in 1990 and 1993. Hypothesis 4.5 is that there will be no differences in 1993 and 1996. Questions 13, 15, and 16 are used to test hypotheses 3.5 and 4.5.

Question 16¹⁴³ identifies changes by packaging commodity. Responses to this question helped indicate whether packaging reduction is being achieved, in part, through changing packaging commodities. Respondents are asked to estimate the type of packaging material utilized by percentage for 1990, 1993, and projected in 1996. The intent of the question was to identify changes from one commodity to another. For example, a change from wooden pallets to slip sheets would be reflected by a decrease in the percentage for one commodity and an increase in the commodity for the other. When respondent replies to the percentage question did not add up to 100%, the difference was allocated proportionally over the items identified.

A stacked bar chart was utilized to graph the changes between each time period. The mean score of each commodity time period was compared using a two sample t-test to determine if a significant change has, or will, occur. The test was against the mean of each group being equal and utilized $\alpha = .05$. A two sample t-test was also conducted between the first

¹⁴³Survey Question #16:

Please estimate the type of packaging material utilized within your company:

Packaging Commodity	1990	1993	1996
Corrugated/Fiber Boxes	%	%	%
Paper Sacks	%	%	%
Plastic/Rubber containers	%	%	%
Plastic Shrink Wrap	%	%	%
Pallets	%	%	%
Metal	%	%	%
Composites	%	%	%
Other _____	%	%	%
TOTAL	100 %	100 %	100 %

and last time periods to determine if a significant change would occur over a longer period of time.

Question 13¹⁴⁴ asked the respondent to identify how much more the company would be willing to pay for returnable packaging if it could be reused two times, five times, and ten times respectively. The survey group was not expected to provide a precise answer to question 13 but to provide an executive level perception of expectations. Comparison of the response to each of the three parts of the question 13 provides a perspective of the relationship and magnitude of the responses.

¹⁴⁴Survey Question #13:

Please indicate how much more your company would be willing to pay for packaging which could be reused compared to one-time use packaging.

Number of times packaging may be re-used		
Two Times (2X)	Five Times (5X)	Ten Times (10X)
%	%	%

Question 15¹⁴⁵ asked the respondent to identify what solid waste management efforts have taken place in 1990 and 1993 and what efforts are projected to take place in 1993 and 1996. Responses to this question help indicate whether packaging reduction is being achieved, in part, through packaging redesign or the use of reusable containers.

Descriptive statistics are utilized to count and report what types of changes have taken place. A two sample t-test was used to determine if there is a significant difference between the efforts from 1990 and 1993 and the projected efforts between 1993 and 1996. The test was against the group means being equal and will utilize $\alpha = .05$.

Hypothesis 3.6 is that there are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993. Hypothesis 4.6 is that there

145 Survey Question #15:

Please identify the solid waste reduction efforts (or anticipated efforts) undertaken by your company:

With Suppliers		With Customer		
Between 90 & 93	Between 93 & 96	Between 90 & 93	Between 93 & 96	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reducing the amount of packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Increasing the number of reusable containers
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Redesigning packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Working to better understand packaging needs
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Use of outside consultants
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Other (please specify)

will be no differences in 1993 and 1996. Questions 7 through 12¹⁴⁶ are used to test hypotheses 3.6 and 4.6. Question 19 was also used to test hypothesis 3.6.

146Survey Question #7:

The procurement function plays a significant role in corporate solid waste reduction.

SA - A - N - D - SD

Survey Question #8:

It is the role of both customer and supplier to actively reduce the solid waste stream.

SA - A - N - D - SD

Survey Question #9:

In the last three years, corporate solid waste reduction efforts have significantly influenced relationships between customers and suppliers.

SA - A - N - D - SD

Survey Question #10:

In the next three years, I expect corporate solid waste reduction efforts will significantly influence relationships between customers and suppliers.

SA - A - N - D - SD

Survey Question #11:

In the last three years, my company made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

Survey Question #12:

In the next three years, I expect my company to make a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

Questions 7 through 12 utilized the five-point Likert scale coding. The mean score of each group was compared using a two sample t-test to determine if a significant number of respondents who have experienced efforts to reduce solid waste have different perceptions of the customer-supplier relationship than those without a solid waste management effort. The test was against the group means being equal and will utilize $\alpha = .05$. In addition, a two sample t-test utilizing $\alpha = .05$ was used to determine if there is a significant difference between the responses of question 9 and question 10. If there is a significant difference and the mean of question 10 is greater than that of question 9, respondents are projecting corporate solid waste reduction efforts will influence supply chain relationships more between 1993 and 1996 than it did between 1990 and 1993. Similar analysis was conducted comparing questions 11 and 12 for supplier relationships. If there is a significant difference and the mean of question 11 is greater than that of question 12, respondents are projecting more effort will be made to work with suppliers to reduce secondary and tertiary packaging material sent to the company between 1993 and 1996 than it did between 1990 and 1993.

Question 19¹⁴⁷ was used to test hypothesis 3.6. Coding for this question assigned a "+1" for a response of "helped us develop a closer working relationship," a "0" for a response of "no change," and a "-1" for a response of "kept us at an arm's length relationship." Responses were grouped utilizing the response to question 23 that identifies if the respondent's company has an "on-going solid waste reduction effort." A chi-square test using $\alpha = .05$ was conducted to determine if efforts to reduce solid waste over the last three years has helped develop a closer working relationship, kept companies at an arm's length relationship, or not changed relationships with the respondent's suppliers and the respondent's customers. Descriptive statistics were also utilized to count and report changes in sourcing complexity.

Data Entry

The initial entry of data was conducted using a LOTUS 1-2-3 Release 2.01 software spreadsheet. The data was transferred to a MINITAB Release 8.0 statistical software program for analysis. All computer calculations utilized a 386SX 16 Hz personal computer. Each

¹⁴⁷Survey Question #19:

How have efforts to reduce solid waste over the last three years modified your relationship?

With Suppliers	With Customers	
<input type="radio"/>	<input type="radio"/>	Helped us develop a closer working relationship
<input type="radio"/>	<input type="radio"/>	Kept us at an arm's length relationship
<input type="radio"/>	<input type="radio"/>	No change
<input type="radio"/>	<input type="radio"/>	Not sure
<input type="radio"/>	<input type="radio"/>	Other (please specify)

survey was recorded and numbered with a unique serial number identifying the industry and respondent surveyed. The analysis of the survey responses is discussed in Chapter Four. The statistical analysis of each question is located in Appendix C.

Desired Sample Size

The following calculations utilize a worst case scenario of standard deviation to calculate desired sample size. The worst case standard deviation assumes the sample will have the maximum standard deviation possible. For the questions using the five point Likert, this means all responses will coded either +2 for "Strongly Agree" or -2 for "Strongly Disagree." The worst case standard deviation score is 2. A 95% confidence interval was selected as it is one of the standard acceptable confidence intervals used in research. The minimum allowable variance between responses of groups is ± 0.5 coding units. The variable represents how far apart mean responses must be before they are considered statistically different at the 95% confidence level. The variance was selected as it represents a common variable for rounding to the nearest integer, thus distinguishing one response from another.

The variables and calculations for determining desired sample size are as follows:

s = Standard deviation of the sample [+2 max, -2 min] = 2

$1.96\sigma_x$ = 0.95 confidence level

± 0.5 = Minimum allowable variance between mean scores to conclude significant differences

σ_x = Standard error of the mean = $\frac{0.5}{1.96} = 0.255$

$$\sigma_x = \frac{s}{\sqrt{n-1}} = 0.255 = \frac{2}{\sqrt{n-1}}$$

$n = 63$ = Desired Sample Size

A sample size of at least 63 responses is required to be able to determine there is a significant statistical difference at a 95% confidence interval for mean responses ± 0.5 coding units apart, using the worst case standard deviation.

It is expected that the sampling technique of this research would have the effect of attaining less variance between responses. Unlike the variance attained from a purely random sample, responses from within each industry likely will be similar, as would the responses of purchasing executives. A larger sample size will allow the researcher to determine significant differences at smaller variances between the mean responses. As in most cases, larger sample sizes are better.

Minimum Allowable Variance	Required Sample Size
± 0.50	n = 63
± 0.40	n = 97
± 0.30	n = 171
± 0.25	n = 246
± 0.20	n = 385

The survey procedures used in this research, such as pre-notification and the use of support letters, will be used to achieve as high of a response rate as economically possible from the 480 purchasing professionals.

Stage Two - Case Study

The second stage of this research involves a field case study methodology to examine approaches in the implementation and maintenance of solid waste management efforts of packaging material. Participants of the case studies were identified by the surveys and from preliminary interviews. Seven case studies were conducted. The case studies started with the survey questions and utilized follow-on questions to further probe and understand the influence of solid waste management efforts on the corporate purchasing function. Wherever possible, the case study investigated solid waste management efforts at multiple scenarios shown in Figure Eight. To better understand the solid waste management

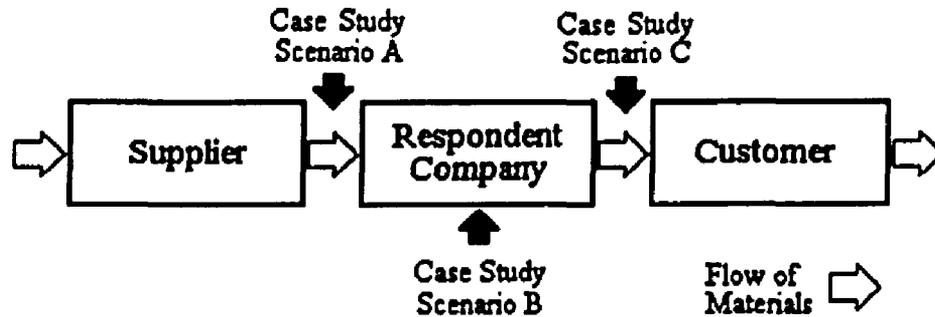
efforts, the case studies sought to analyze the following scenarios throughout the supply chain:

Case Study Scenario A - Respondent company works with supplier to reduce incoming primary, secondary, and tertiary packaging material.

This scenario involves the case study company working closely with its suppliers to avoid receiving packaging material that will ultimately enter the respondent company's solid waste stream. Efforts with suppliers may include packaging redesign, reuse, involvement in a retrieval system to return packaging material to the supplier, or use of alternative forms of packaging material.

Case Study Scenario B - Respondent company reduces primary, secondary, and tertiary packaging material used internally through alternative packaging, reusable containers, and challenging the need for packaging.

This scenario involves the case study company working internally to reduce the amount of primary, secondary, or tertiary packaging material that will ultimately enter the respondent company's solid waste stream. Internal efforts may include redesign of packaging used internally, packaging reuse, recycling, using alternative forms of packaging material, or eliminating packaging by re-engineering a process.



Case Study Scenario A	Respondent company works with supplier to reduce incoming primary, secondary, and tertiary packaging material.
Case Study Scenario B	Respondent company reduces primary, secondary, and tertiary packaging material used internally through alternative packaging, reusable containers, and challenging the need for packaging.
Case Study Scenario C	Respondent company reduces the amount of outgoing primary, secondary, and tertiary packaging material used to meet the request of customers.

Figure 8
Case Study Scenarios in the Supply Chain

Case Study Scenario C - Respondent company reduces the amount of outgoing primary, secondary, and tertiary packaging material used to meet the request of customers.

This scenario involves the case study company working closely with its customers to reduce the amount of primary, secondary, and tertiary packaging material used in packaging its outbound products. The request may come formally from the customer or informally as a result of government regulations. One of the case study companies is addressing the German markets and must fulfill the German environmental packaging guidelines. Efforts may include packaging redesign, reusable containers, utilizing a retrieval system to recover packaging material from the customers, or use of alternative forms of packaging material.

In addition to the information obtained from the original survey questions, the following questions were developed following the survey analysis:

1. What motivated the corporation to address packaging solid waste reduction.
2. How were solid waste reduction goals determined.
3. How is the company managing their solid waste.
4. How are solid waste management efforts tracked and measured.
5. How is solid waste management considered in company business cases.

6. How does the company involve customers in their solid waste management effort.
7. How is the company organized to facilitate sourcing and buying activities.
8. What role does purchasing play in corporate solid waste management.
9. What organizational changes were made to support solid waste management that affects purchasing.
10. What purchasing skills are required to support the solid waste management.
11. How have solid waste management efforts affected sourcing complexity.
12. What would companies have done differently.

The final question of the survey asked companies to indicate if they would be willing to participate further in a field case study. A total of thirty companies offered further involvement, with 14 from the chemical industry, 9 from the electronics industry, and 7 from the food and beverage industry.

The thirty companies were grouped by geographic region in an attempt to minimize the amount of travel required to conduct the case studies. The list was reduced by selecting companies in the geographic areas around Boston, Philadelphia, and Raleigh-Durham. The initial plans of the researcher were to make all of the case studies on-site visits and to minimize travel costs. A summary of preliminary survey results was mailed with a cover letter to the companies selected. The cover letter was

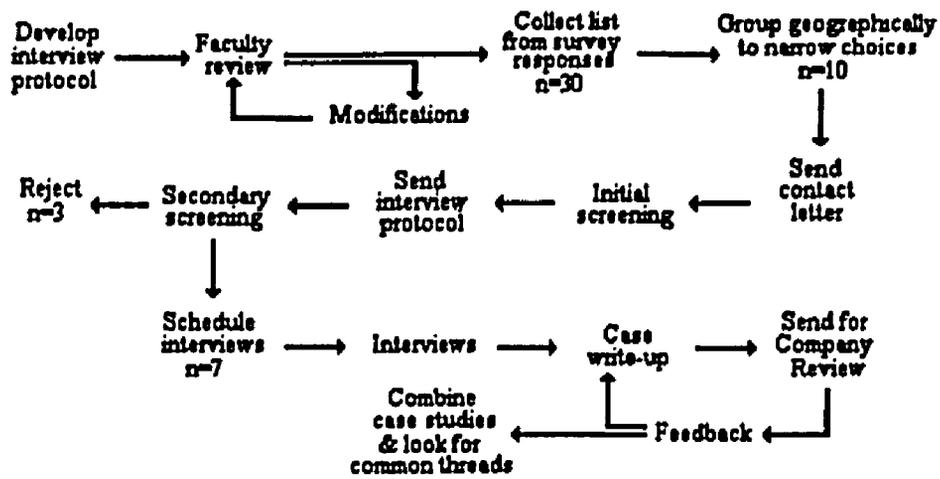


Figure 9

Case Study Research Process

used as a reminder of their offer to participate in a field case study and indicated that the researcher would be calling on a specific date to discuss the details of a potential case study.

Each company was contacted by telephone and screened to determine if the case study would provide sufficient information beyond that of the mail survey. An outline of the case study process and potential visit dates were discussed. The screening process eliminated one electronics company and two food companies. One company suggested conducting a case study using the telephone and offered to send a package of documents prior to the case study. The researcher had previously been employed with the company and had sufficient comfort with using this method.

Two of the three food companies initially selected were eliminated during pre-screening. In an attempt to find a case study company in the food and beverage industry which was within close proximity to the researcher's home, the researcher contacted a packaging consultant who offered the names of client companies which might be willing to take part in a case study. The first company contacted was willing to participate.

The case studies involved in-depth interviews with one or more employees of the company. Those interviewed include employees from the purchasing function and functional areas such as Finance, Packaging Design, Manufacturing, Marketing, and Personnel, with whom the purchasing function interacts with in order to meet corporate solid waste management goals. Each study participant was personally interviewed, in

an attempt to gain an in-depth understanding of the issues relating to the influence of corporate solid waste management on the participant's area. Individuals interviewed were sent an advanced copy of interview protocol questions before the interview. Each interview explored solid waste management efforts internal to the company and with customers or suppliers. The case studies ran in duration from a two hour telephone call using supporting documents which were mailed ahead of time to eight hours in duration. After each case study was completed, a summary of the case study was written and a facsimile was sent to the case study contact person to review for correctness.

Direct Funding

Funding for the research came from three areas. First, the Marketing and Logistics department at The Ohio State University provides a one-time research stipend to each doctoral student. Second, the researcher was awarded the American Society of Transportation and Logistics L. L. Waters Scholarship. Both the research stipend and the scholarship funds were designated by the researcher to help fund this dissertation. Finally, major funding for this research was awarded by the National Association of Purchasing Management under its doctoral dissertation grant program.

Summary

This chapter outlined the steps in the research process used to carry out the study. The research questions and hypotheses were developed in

detail. The survey questionnaire was explored in detail discussing each question as it was cross-referenced and how the question was tested. Criterion for selecting members of the survey sample was reviewed. A case study interview protocol was discussed.

The research involves a two-stage methodology. The first stage is a mail survey used to determine how corporate solid waste management efforts of packaging material have affected purchasing and projecting how the solid waste management efforts of packaging material will affect purchasing in the next three years. The second stage is a field case study used to examine approaches to the implementation and maintenance of solid waste management efforts of packaging material within case study companies and throughout the supply chain.

CHAPTER IV

DATA FINDINGS AND ANALYSIS

Introduction

The data collection process is developed in detail in this chapter. The pre-calling effort is discussed and identifies the advantages of phonemail in reducing the number of callbacks. The response time for each survey is measured and is reported. The demographics of the survey respondents are identified. The survey analysis addresses non response bias and the validity of responses by individuals who have had less than three years in their current position. Each hypothesis is addressed through the analysis of specific survey results, the findings summarized, and each hypothesis is accepted or rejected. The case study results are compiled and summarized by interview protocol question.

Stage One: Mail Survey

The first stage of the research was to survey purchasing executives from the chemical, food and beverage, and electronics industries. The methodology involved pre-calling the executives prior to sending out the mail survey.

Survey Pre-Calling

The mailing list of purchasing executives was called prior to sending out the survey. The pre-calling took place over a 10 day period. There was an average of 77 calls made per day at a rate of approximately ten calls hour. The calls were preceded by a notification letter mailed seven to ten days before the scheduled call. The letter was written under the signature of the dissertation advisor and indicated a doctoral student would be calling to ask consent to send a survey in support of a doctoral dissertation.

On of the first day of calling, directory assistance was used to obtain the corporate telephone number which proved to be burdensome and resulted in limited success. Companies often have multiple addresses within a city or are listed under a different corporate name, such as the corporate parent. An alternative method was used in which the company name was cross-referenced on Dun's Million Dollar Directory with the executive's mailing address. Dun's lists all locations of a company and provides a telephone number for each location and proved to be very successful in providing a telephone number to the specific site location of the executive to be contacted.

Calls made to the telephone number listed in Dun's would typically reach a site operator. It is a common practice for purchasing personnel not to allow their telephone number to given out by the corporate operator help reduce the number of cold sales calls. After the researcher indicated the call was research oriented, the site operator would transfer the call to the executive's secretary or directly to the executive. On occasion, the

operator would verbally provide the telephone number before transferring the call.

Calls transferred to the secretary of the executive met various results. In some cases, the executive had notified the secretary that he or she was expecting a call from The Ohio State University and to let the call through. Sometimes the secretary had processed the executive's mail and was aware that the call was coming. In one isolated case, the executive secretary indicated that the executive "did not fill out surveys" and the researcher should be prepared for a negative response to the request to send him a survey. She then transferred the call to the executive. The line disconnected after a loud slamming sound. The original telephone number called again. The secretary reported the executive had accidentally dropped the telephone and was waiting for the call. After the call was transferred, the executive sheepishly indicated that he would "gladly fill out his first survey ever."

Affiliation with Ohio State University proved very effective in getting past the secretary. Most of the gatekeeper responsibilities in Purchasing are oriented toward keeping out cold sales calls. The affiliation with an academic institution indicated the call was not marketing or sales related. Academic affiliation was indicated at the very beginning of the call.

When the executive had finally been reached, the following message was used:

"My name is Ted Farris and I am calling from The Ohio State University regarding a letter you recently received about research I am conducting for my doctoral dissertation.

I am calling to ask for your assistance in completing a written survey which will take about 10 minutes of your time to complete."

Every attempt was made to speak directly to the executive. If the executive was not available, a message was left either with the secretary or on phonemail. Often a secretary would transfer the call to the executive's phonemail to allow a verbal message to be left. While no logs were kept tracking the results, messages left on phonemail seemed to receive more call backs from the executives than messages taken by secretaries. When transferred to a phonemail or answering machine, the following message was added to the end of the original message.

"...please call my phonemail at area code (614) 292-2959 to indicate if you would like to participate in the survey, and I'll mail it right out to you; or if you do not wish to participate in the survey.

Again, my phonemail number is (614) 292-2959. My research is partially funded by The Ohio State University and The National Association of Purchasing Management. Thank you for your assistance, I am looking forward to your feedback."

Any messages left indicated that the return call would contact a phonemail message which meant the executive could call back at his convenience and leave a quick "yes" or "no" with minimal effort. Use of phonemail messaging was used to reduce telephone tag. The phonemail system allowed the researcher to make phone calls without worrying about tying up the phone line for callbacks from the executives. It also helped provide around the clock telephone coverage.

When the executive made the return call, he was greeted with the following message:

"Welcome to the Ohio State University. You have reached the office of Ted Farris....Please leave your name, phone number and the reason you called. If you are calling about the NAPM - Ohio State survey, please indicate if you would like to receive the survey or if you would not like to participate. Thank you for your help!"

The researcher's phonemail system was checked for messages every two hours between 8:00 AM and 8:00 PM for the ten day calling period and the four days following. Most of the messages were simple "yes" or "no" replies but additional information was sometimes left by the executive regarding an alternative person in the organization to receive the survey. If the executive requested additional information, a return call was made within twelve hours.

Table 19

Sample of Computer Database Variables

	Phone Number	Mailing Address	Pre-Notify & Mailed	# of Phone Calls	(Yes = 1, No = 0)		
					Commit	Request Details	Case Study
C 51	(614) 555-1212	Ted Farris VP of Purchasing XYZ Company 1993 Main Street Akron, OH 43210	June 15 June 27	3	1	0	1

When a "no" response was received, the computer database was updated and the unused mailing label was removed and discarded. The computer database was updated nightly in preparation for calls on the following day.

When a "yes" response was received, the database was updated and the mailing label was placed on the mailing envelope. A tri-folded copy of the 8 1/2" x 11" survey, a #10 postage paid pre-addressed return envelop, and a bi-folded support letter from the Executive Director of NAPM measuring 5 1/2" x 8 1/2" were sealed in a 6 1/2" x 9 1/2" off-yellow colored envelop containing the logo of The Ohio State University and return address. Surveys were deposited in the College of Business out-going mail in time to be processed by the campus mail service that evening. On the days the pre-calling extended beyond 6:00 PM, the surveys were personally delivered to campus mail services. All surveys were mailed at the business rate using a university mail account code.

After survey mailing, the computer database was updated and mailing labels were printed using a Hewlett-Packard LaserJet IIP printer for the following day. Address changes from that day's calls were input, updated labels were generated, and envelopes were completed for mailing the next day. Any remaining mailing labels left over at the end of the day served as a secondary check for computer database correctness. Remaining labels represented names where a message had been left for the executive. Any names on mailing labels aged two days were called again.

A total of 769 telephone calls were made to 480 executives which was an average of 1.6 calls per name. There was no difference in the average number of calls by industry group. When using a similar pre-calling technique in 1985, McQuiston averaged three calls per executive.¹⁴⁸ The use of phonemail technology was used to reduce the total number of callbacks required. The greatest number of calls required to obtain an answer from an executive was seven calls.

The pre-calling technique reduced the original 480 name list of executives by 91 names, a reduction of 19%. The percentage of "No" responses was 15.3% for the chemical industry, 18.5% for the Food and Beverage industry, and 23.4% for the Electronic industry. The researcher was unable to contact 86 executives due to executive vacation schedules, incorrect telephone numbers, and non-response to multiple messages left by the researcher. Surveys were sent to these executives with a letter indicating the numerous unsuccessful attempts to contact the executive and a written request for the executive to complete and return the enclosed survey.

¹⁴⁸Per June 2, 1993 discussion with Daniel H. McQuiston on his efforts for his unpublished dissertation, "The Relative Participation of Functional Roles in the Industrial Decision Making Unit." The Ohio State University, 1985.

Table 20
Mail Survey Response Rate

	Chemical	Electronic	Food	TOTAL
TOTAL NAMES	176	158	146	480
NO	27	37	27	91 (19.0%)
YES, send survey	116	96	91	303 (63.1%)
Sent without commitment	33	25	28	86 (17.9%)
PHONE CALLS MADE	290	246	233	769
FINAL RESULTS				
YES, send survey	79	56	51	186 (61.4%)
Sent w/o commitment	7	7	5	19 (22.1%)
TOTAL RESPONSES	86 (57.7%)	63 (52.1%)	56 (47.1%)	205 (52.7%)

Survey Response Details

A total of 205 of the 389 surveys mailed were completed and returned by the executives representing an overall response rate of 52.7%. The chemical industry had a 57.7% response rate, the highest of the industries. The food and beverage industry had the lowest response rate of 47.1%. The electronics industry had a response rate of 52.1%.

The pre-calling technique affected the response rate. Of the 303 oral commitments to complete the survey, 61.4% actually completed and returned the survey. There were also 86 executives receiving surveys where the pre-calling technique did not obtain a commitment to complete the survey. These executives received the same survey package as those orally committing to complete the survey. A total of 19 executives actually completed the survey and returned it for a response rate of 22.1%. The response rate for McQuiston was 62.6%.

The executives were offered an executive summary of the survey results on request. A total of 31 executives, 15.1% of the total responding to the survey, requested the executive summary.

The final question on the survey asked executives if they would be willing to participate in a field case study. A total of 29 executives, 14.1% of the total responding to the survey, offered to participate further with 14 from the chemical industry, 9 from the electronics industry, and 7 from the food and beverage industry.

The response time was tracked for all survey responses. The mailing computer database included the date the survey was mailed to the executive. When a survey response was received in the mail, the postmark was recorded and compared to the date the survey was initially mailed. The recorded turnaround time includes mail transit time from Ohio State mail services to the executive, time for the executive to receive and fill out the survey, and time for the response to go from the executive's office to the post office to be postmarked. A total of 193 out of the 205 responses received contained a legible postmark. The fastest turnaround took two days, the longest took 68 days. The highest percentage of responses were processed within five to seven days.

An adjustment was made to the original survey methodology to account for the amount of time it took campus mail services to process the receipt of business reply return envelopes. Postmarks on survey replies received on July 9 and August 5 were analyzed to determine the amount of time it took to receive the survey reply after it was postmarked. It took the sample of 37 survey replies an average of 6.6 days to go through both the U. S. Postal system and Ohio State Campus Mail Services. The minimum amount of time through the system took three days. The maximum amount of time through the system took ten days. The campus mail services places a lower priority on business reply envelopes that require an additional step of processing to record the campus mail account number and accumulates them for volume processing. After the additional mail processing time was identified, the second mailing of surveys was postponed for a week.

n = 193 out of 205

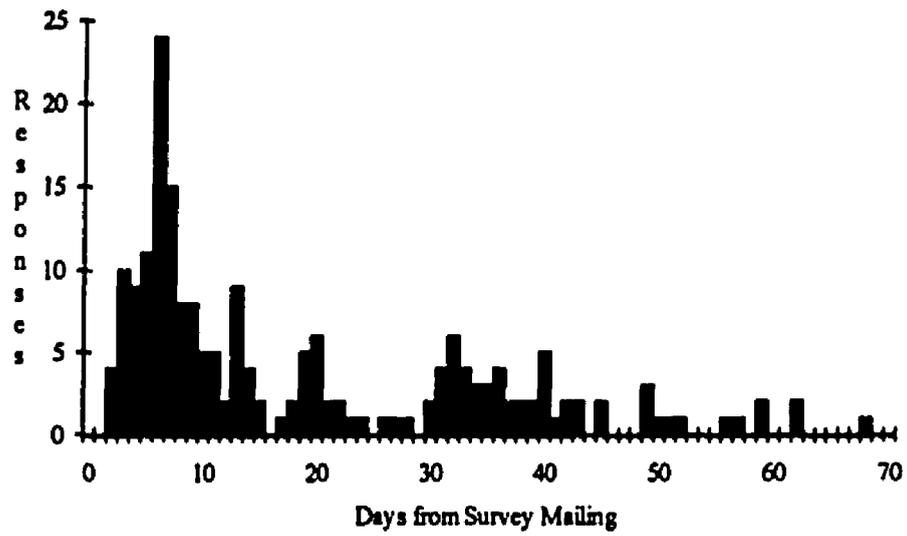


Figure 10

Time Required for Survey Responses

n = 193 out of 205

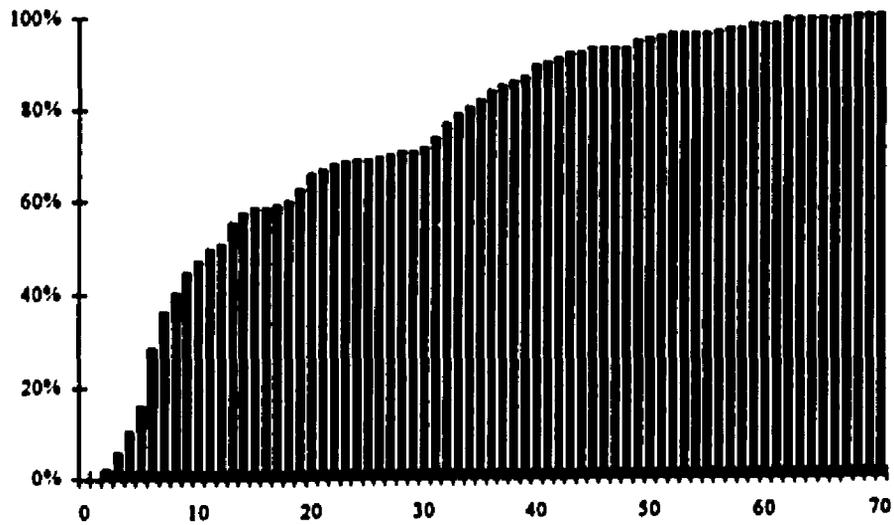


Figure 11

Cumulative Time Required for Survey Responses

Table 21

Campus Mail Services Turnaround

Surveys received on July 9

Postmark	Quantity	Age
June 29	1	10 days
June 30	2	9 days
July 1	6	8 days
July 2	5	7 days
July 6	6	3 days
	Average:	6.5 days

Surveys received on August 5

Postmark	Quantity	Age
July 27	3	9 days
July 28	4	8 days
July 29	5	7 days
July 30	2	6 days
August 2	3	3 days
	Average:	6.8 days

NOTE:

"Turnaround" is defined as the time between envelop postmark and receipt at the researcher's campus mailbox

A secondary mailing was conducted. Unique coding and tracking of secondary mailing did not occur. Survey response turnaround was tracked base on the mailing date of the first survey. Over 70% of the 205 survey responses had been received when the secondary mailing took place. The analysis of the survey is in Appendix C.

Respondent Demographics

The survey mailing list was comprised of purchasing vice presidents and directors of the food and beverage, chemical, and electronics industries. While most of the vice presidents and directors completed the survey themselves, 36% passed the survey to an employee. Survey question 22¹⁴⁹ asked the respondent to list their position or title. There were 126 responses that indicated executive level positions of Director, Vice President, Owner, President, or General Manager filled out the survey representing 64% of the respondents indicating their title. The remaining positions included Executive Assistant, Manager, Purchasing Head, Senior Buyer, and Engineer.

149Survey Question #22:

What is your position or title?

How long have you held this position? _____

Differences in Solid Waste Management Effort

On the final page of the survey, companies were asked to indicate if they had an on-going solid waste reduction effort¹⁵⁰ at the end of the survey to reduce the possibility of respondents disqualifying themselves if they did not have a solid waste reduction effort. Had the question been asked at the beginning of the survey, some respondents potentially would disqualify themselves and stop filling out the survey. Out of 202 companies answering the question, 131 (64.9%) indicated they had some type of on-going solid waste reduction effort and 71 (35.1%) did not.

A significant number of companies surveyed had "on-going" solid waste management efforts. Of the companies surveyed, there was a significant difference in the number of companies reporting that they had a solid waste reduction effort in the food and beverage ($p=0.0061$) and the chemical industries ($p=0.083$) then in the electronics industry. There was no significant difference ($p=0.21$) between the food and beverage industry and the chemical industry.

Summary:

A significant number of respondents reported that they had an "on-going" solid waste effort. The food and beverage industry and the chemical industry had significantly more respondents reporting an "on-going" effort.

¹⁵⁰Survey Question #23:

Does your company have a on-going solid waste reduction effort?

- Yes No

Details of Solid Waste Reduction Efforts

The companies reporting that they had an on-going solid waste reduction effort were asked to further describe their effort.¹⁵¹ Out of 120 responses, 64 (53.3%) indicated they had a formal, documented effort. An ANOVA test indicated there was no significant difference ($p=0.242$) between the industries surveyed. The electronics industry had the highest percentage of respondents reporting a formal policy. Out of 119 responses, 83 (69.7%) indicated they share their waste reduction effort with their suppliers. The ANOVA test indicated there was no significant difference ($p=0.236$) between industries surveyed. The food and beverage industry had the highest percentage of respondents reporting sharing their efforts with suppliers. Out of 120 responses, 77 (64.2%) indicated they had integrated their solid waste reduction effort within their procurement procedures. The ANOVA test indicated there is a significant difference ($p=0.053$) between two or more industries. Further analysis determined the food and beverage industry is significantly different from the chemical industry ($p=0.0052$) and the electronic industry ($p=0.0535$) reporting integration of their solid waste reduction efforts into purchasing procedures.

¹⁵¹Survey Question #24:

How are each of the following primarily managed? (Please check one level only)

Procurement	Solid waste	
<input type="radio"/>	<input type="radio"/>	On a corporate level
<input type="radio"/>	<input type="radio"/>	On a local/divisional level
<input type="radio"/>	<input type="radio"/>	Both

T-tests were conducted to analyze the relationship between having a formal solid waste reduction policy, integrating the policy in purchasing procedures, and sharing the solid waste reduction effort with suppliers.

Out of 113 combined responses, there was no significant difference ($p=0.45$) between those companies with a formal, documented effort and those lacking a formal, documented effort in whether they integrate the effort in their purchasing procedures.

Summary:

Integration of a solid waste reduction effort into procurement procedures is not dependent on having a formal, documented effort.

Out of 115 combined responses, there was a significant difference ($p=0.0000$) between the number of companies reporting that their solid waste reduction efforts are integrated within their procurement procedures and the number of companies who have not integrated their solid waste reduction effort within their procurement procedure in whether they share their solid waste reduction efforts with their suppliers.

Summary:

Companies are more likely to share their solid waste reduction efforts with suppliers if the effort has been integrated into purchasing procedures.

Out of 114 combined responses, there was a significant difference ($p=0.086$) between those companies with a formal, documented effort and those companies without a formal, documented solid waste reduction effort in whether they share their effort with their suppliers.

Summary:

Companies are more likely to share their solid waste reduction efforts with suppliers if the solid waste reduction effort is formal and documented.

Likert Scale

Survey questions 1 through 12 used a five point Likert scale to ask respondents to indicate whether they "Strongly Agreed," "Agreed," were "Neutral," "Disagreed," or "Strongly Disagreed" with a statement. Responses were coded using +2 for "Strong Agree," +1 for "Agree," 0 for "Neutral," -1 for "Disagree," and -2 for "Strongly Disagree." ANOVA was used to determine if there were significant differences between industries. A summary of the ANOVA results for questions 1 through 12 is found in Table 12.

The mean responses for questions 7 and 11 were significantly different from the expected means which indicates industry responses were statistically different between two or more pairs of means. Further discussion of each Likert question as it was used to test hypotheses follows.

Table 22

Summary of ANOVA Analysis for Questions 1 Through 12

Q	Test $\mu_{\text{Chemical}} = \mu_{\text{Electronic}} = \mu_{\text{Food}}$			P Value	Test $\mu_{\text{effort}} = \mu_{\text{no effort}}$		
	Means				Means		
	Chemical	Electronic	Food		With Effort	W/Out Effort	P Value
1	0.612	0.698	0.964	0.154	0.977	0.260	0.0000
2	1.188	1.222	1.273	0.816	1.402	0.903	0.0000
3	-0.118	-0.222	0.182	0.083	0.159	-0.542	0.0000
4	0.353	0.349	0.600	0.337	0.621	0.010	0.0001
5	0.906	1.097	1.037	0.352	1.162	0.722	0.0003
6	0.435	0.468	0.600	0.595	0.557	0.360	0.17
7	0.821	0.935	1.200	0.029	1.038	0.817	0.064
8	1.345	1.435	1.382	0.668	1.469	1.222	0.0056
9	0.059	0.081	0.364	0.146	0.267	-0.083	0.011
10	0.800	0.774	0.745	0.922	0.939	0.458	0.0001
11	-0.082	0.032	0.618	0.000	0.473	-0.500	0.0000
12	0.741	0.806	0.927	0.434	1.084	0.278	0.0000

The mean responses for all Likert questions were higher by those companies reporting a solid waste reduction effort than those reporting that they did not have a solid waste reduction effort. The mean responses for questions 1, 2, 3, 4, 5, 8, 9, 10, 11, and 12 were all significantly different with p-values of 0.011 or less. Question 7 was interpreted as significantly different ($p=0.064$). Question 6 was not significantly different ($p=0.17$) for companies with a solid waste reduction effort than those companies without a solid waste reduction effort.

The food and beverage had stronger mean responses closer to either end of the Likert scale followed by the electronics industry. The coding for the Likert scale questions 1 through 12 scored a 0 for "Neutral." A larger absolute value for a mean response indicates a stronger response away from a neutral position. For example, the mean response for question 7, was 1.200 for the food and beverage industry, 0.935 for the electronics industry, and 0.821 for the chemical industry. The mean response for the food and beverage industry represents a mean response closer to "Strongly Agree" than the mean response for either of the other two industries.

Respondent Tenure in Current Position

A comparison was conducted investigating the difference in the responses of those with less than three years in the current position versus those with more than three years in the current position. Respondents were asked to indicate how long they had held their present position. The average period of time in the reported position was 5.9 years, the longest

A chi-square analysis indicates that companies with a solid waste reduction effort made significantly more ($p=0.0000$) organizational changes addressing solid waste than companies without a solid waste effort. The analysis indicates those companies with a formal documented effort made significantly more organizational changes ($p=0.0345$), companies sharing their effort with suppliers made significantly more organizational changes ($p=0.0773$), and companies integrating solid waste reduction efforts into their purchasing procedures made significantly more organizational changes ($p=0.0497$).

The food and beverage industry had the highest percentage of responses indicating organizational changes between 1990 and 1993 and also projected by 1996.

Summary:

Reject hypothesis 1.1. The purchasing organizational structure has been modified to support solid waste management efforts in 1990 and 1993.

It should be noted that 15 of the 70 companies reporting they did not currently have an on-going solid waste reduction effort indicated they had made 22 organizational changes addressing solid waste reduction. While some companies do not an on-going corporate solid waste reduction effort, purchasing has already started addressing the issues. In addition, 41 of the companies reporting they did not currently have a solid waste reduction effort projected 59 organizational changes would be made by 1996.

Hypothesis 1.2

The second hypothesis of the first research question is that there are no differences in skills required by purchasing to support solid waste management efforts between 1990 and 1993. Survey question 6¹⁵³ used a five point Likert scale to ask if solid waste management required special or unique procurement skills. None of the industry means were significantly different. The 0.557 mean score of companies reporting a solid waste management effort was not statistically significantly different ($p=0.17$) from the 0.360 mean score of the companies reporting they did not have a solid waste management effort. Perceptions of special or unique skill requirements are effectively similar. The result of the analysis of survey question 6 leads to the rejection of hypothesis 1.2 that there are no difference in the skills required by purchasing to support solid waste management efforts prior to 1990.

Summary:

Reject hypothesis 1.2. The skills required by purchasing to support packaging solid waste management efforts changed between 1990 and 1993.

Hypothesis 1.3

The third hypothesis of the first research question is that there are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993. Survey questions 1, 3, and

¹⁵³Survey Question #6:

Solid waste reduction requires special or unique procurement skills.

SA - A - N - D - SD

4 used a five point Likert scale to ask how solid waste consideration affected procurement decisions. None of the industry means were significantly different.

Survey question 1¹⁵⁴ asked the company to indicate if there had been a significant change in how the company considered solid waste issues in procurement decisions from 1990 to 1993. The 0.977 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0000$) than the 0.260 mean score of companies reporting they do not have a solid waste management effort.

Survey question 3¹⁵⁵ asked the company to indicate if the amount of packaging material used by a supplier is considered when selecting a supplier. The 0.159 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0000$) than the -0.542 mean score of companies reporting they do not have a solid waste management effort.

1⁵⁴Survey Question #1:

In the last three years, there has been a significant change in how we consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

1⁵⁵Survey Question #3:

The amount of packaging material used by a supplier is considered when selecting a supplier.

SA - A - N - D - SD

Survey question 4¹⁵⁶ asked the company to indicate if the amount of packaging material used by a supplier is more important in 1993 in the supplier selection process than it was in 1990. The 0.621 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0001$) than the 0.010 mean score of companies reporting they do not have a solid waste management effort.

Summary:

Reject hypothesis 1.3. The purchasing "buy" decision has been influenced by packaging solid waste management efforts between 1990 and 1993.

- There has been a significant change in how we consider solid waste issues in procurement decisions.
- The amount of packaging material used by a supplier is considered by those companies with a solid waste management effort.
- The amount of packaging material used by a supplier is more important in 1993 than it was in 1990.

Hypothesis 1.4

The fourth hypothesis of the first research question is that there are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision

156 Survey Question #4:

The amount of packaging material used by a supplier is more important now in the supplier selection process than it was in 1990.

SA - A - N - D - SD

which does not consider packaging solid waste management efforts between 1990 and 1993.

Survey question 20¹⁵⁷ asked companies to indicate if their solid waste management efforts between 1990 and 1993 had changed sourcing lead time. A chi-square comparison was conducted to compare the responses by companies with a solid waste management effort and those without a solid waste management effort. The coding used for the chi-square analysis used a "+1" for a response indicating "increased sourcing lead time," a "0" was used for a response of "no change," and a "-1" was used for a response indicating "reduced sourcing lead time." There was no significant difference ($p=0.67$) in the responses of companies with a solid waste management effort and companies without a solid waste management effort.

Summary:

Accept hypothesis 1.4. There has been no difference in the time it takes to make a sourcing decision which supports packaging solid waste efforts in 1990 and 1993.

157 Survey Question #20:

Over the last three years, our solid waste reduction efforts have:

- increased sourcing lead time
- not changed the sourcing lead time
- reduced the sourcing lead time

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

Hypothesis 1.5

The fifth hypothesis of the first research question is that there are no differences in the complexity it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not consider packaging solid waste management efforts between 1990 and 1993.

Survey question 21¹⁵⁸ asked companies to indicate if their solid waste management efforts between 1990 and 1993 had changed sourcing complexity. A chi-square comparison was conducted to compare the responses by companies with a solid waste management effort and those without a solid waste management effort. The coding used for the chi-square analysis used a "+1" for a response indicating "increased the complexity of sourcing," a "0" was used for a response of "no change," and a "-1" was used for a response indicating "reduced the complexity of sourcing." There was a significant difference ($p=0.007$) in the responses of companies with a solid waste management effort and companies without a solid waste management effort.

¹⁵⁸Survey Question #21:

Over the last three years, our solid waste reduction efforts have:

- increased the complexity of sourcing
- not changed the complexity of sourcing
- reduced the complexity of sourcing

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

more ($p=0.0003$) changes are expected between 1993 and 1996 than were reported to have been made between 1990 and 1993.

Summary:

Reject hypothesis 2.1. There will continue to be changes to the purchasing organizational structure to support packaging solid waste management efforts between 1993 and 1996.

Hypothesis 2.2

The second hypothesis of the second research question is that there are no differences between companies with packaging solid waste management efforts and those that did not have a packaging solid waste management effort on the buy decision in 1993 and 1996. Survey questions 2 and 5 used a five point Likert scale to ask companies to project how solid waste consideration would affect procurement decisions between 1993 and 1996. None of the industry means were significantly different.

Survey question 2¹⁶⁰ asked the company to indicate if there would be additional pressure to consider solid waste issues in procurement decisions between 1993 and 1996. The 1.402 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0000$) than the 0.903 mean score of companies reporting they do not have a solid waste management effort.

160Survey Question #2:

In the next three years, I expect additional pressure to consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

Survey question 5¹⁶¹ asked the company to indicate if the amount of packaging material used by a supplier will be more important in the supplier selection process in 1996 than it was in 1993. The 1.162 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0003$) than the 0.722 mean score of companies reporting they do not have a solid waste management effort.

The combination of the results for questions 2 and 5 lead to the rejection of hypothesis 2.2 that there will be no differences in the influence of solid waste management efforts on the "buy" decision between 1993 and 1996.

Summary:

Reject hypothesis 2.2. There will be additional pressure to consider solid waste issues in procurement decisions.

The amount of packaging material used by a supplier will be more important in 1996 than it was in 1993 for all companies in general and it will be more important to companies with solid waste management efforts than to those without solid waste management efforts.

161 Survey Question #5:

The amount of packaging material used by a supplier will be more important in 1996 in the supplier selection process than it is now.

SA - A - N - D - SD

Hypothesis 2.3

The third hypothesis of the second research question is that there will be no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not consider packaging solid waste management efforts in 1993 and 1996.

Survey question 20¹⁶² asked for the respondent to indicate if their response for the past three years would continue. The question structure was faulty in that it did not ask for the direction of the change. The design flaw affects 26 of the 179 responses. When analyzing the responses, a "0" was used for 131 responses of "not changed the sourcing lead time." In addition 6 responses indicated the increase to sourcing lead time would not continue in the next three years. A "+1" was used to indicate any response suggesting a change to lead time or that the "no change to sourcing lead time" would not continue over the next three years. The primary flaw in this analysis was that the 6 responses indicating increased sourcing lead times would not continue could possibly have reported the sourcing lead times would reduce. The coding assumes lead times would not change in

162 Survey Question #20:

Over the last three years, our solid waste reduction efforts have:

- increased sourcing lead time
- not changed the sourcing lead time
- reduced the sourcing lead time

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

length after an increase had occurred in the past three years. The 0.2346 mean score for projections between 1993 and 1996 was significantly different ($p=0.042$) than the 0.1505 mean score for responses for 1990 to 1993.

A chi-square comparison of the responses by companies with a solid waste management effort and those without a solid waste management effort indicated no significant difference ($p=0.16$) between the two responses.

Summary:

Reject hypothesis 2.3. There will be a difference in the time it takes to make a sourcing decision which supports packaging solid waste efforts between 1993 and 1996.

Hypothesis 2.4

The fifth hypothesis of the second research question is that there will be no differences in the complexity of a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not consider packaging solid waste management efforts in 1993 and 1996.

Survey question 21¹⁶³ asked companies to indicate if their solid waste management efforts between 1993 and 1996 would change sourcing complexity. The responses were coded using "+1" for a response of "increased the complexity of sourcing" or "decreased the complexity of sourcing" and a "0" for response of "no change." The second part of question 21 had the same design flaw as the one stated for question 20 in hypothesis 2.3. A chi-square comparison of the responses by companies with a management effort and those without a management effort indicated no significant difference ($p=0.193$) between the two responses.

Summary:

Reject hypothesis 2.4. There will be a difference in the complexity of sourcing decisions which support packaging solid waste efforts between 1993 and 1996.

163 Survey Question #21:

Over the last three years, our solid waste reduction efforts have:

- increased the complexity of sourcing
- not changed the complexity of sourcing
- reduced the complexity of sourcing

Over the next three years do you expect this trend to continue?

- Yes
- No
- If No, why not?

Hypotheses 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3 and 4.4

The first four hypotheses of the third research question are that there are no differences in the weight and volume of both inbound and outbound packaging used in 1990 and 1993. The first four hypotheses of the fourth research question are that there are no differences in the weight and volume of both inbound and outbound packaging used in 1993 and 1996.

Survey question 14¹⁶⁴ asked companies identify changes between 1990 and 1993 and project changes for 1993 to 1996. The mean scores of all the responses reflect a consistent trend toward reduction of packaging weight and volume from an average of 9.3% between 1990 and 1993 to an average of 15.8% projected between 1993 and 1996.

When the reported reduction for the period between 1990 and 1993 was compared to the projected reduction for the period between 1993 and 1996, all mean scores for the latter were significantly different from the

¹⁶⁴Survey Question #14:

Please provide your best estimate of packaging reduction efforts by:

	Between 1990 & 1993		Between 1993 & 1996	
	By Weight	By Volume	By Weight	By Volume
Your Company				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%
Your Suppliers				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%

mean scores of the former. The p-values ranged from a low of 0.0006 to a high of 0.014. Detailed analysis for question 14 is located in Appendix C.

The consistent trend toward reduction of packaging weight and volume may be the result of factors other than solid waste management efforts. A key factor may be logistical cost reduction efforts to reduce warehousing costs by maximizing packaging utilization, improving transportation efficiencies through optimizing shipping cube, and reducing the amount of expenditures for packaging material. Another factor could be the development of alternative methods and materials in packaging.

The mean scores for question 14 for companies reporting a solid waste management effort were not significantly different from the mean scores of companies reporting they do not have a solid waste management effort. P-values ranged from 0.95 to 0.13. The two lowest p-values were for primary packaging weight with suppliers. The only significant difference between responses, with a p-value of 0.034, was for weight reductions of primary packaging with suppliers between 1990 and 1993. The differences for weight reductions of primary packaging with suppliers between 1993 and 1996 were not significant ($p=0.085$) at the 95% confidence level but may be interpreted as significant at the 91.5% confidence level.

The consistent trend toward the reduction of packaging weight and volume leads to the rejection of hypothesis 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, and 4.4.

Summary:

Reject hypothesis 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, and 4.4. Weight and volume of primary, secondary, and tertiary inbound and outbound packaging material was reduced between 1990 and 1993. There will continue to be improvements to weight and volume of primary, secondary, and tertiary inbound and outbound packaging material between 1993 and 1996.

Between 1990 and 1993, companies with a packaging solid waste management effort had greater reductions of the weight of primary packaging material received from suppliers than those companies without a solid waste management effort. A trend which likely will continue between 1993 and 1996.

Hypothesis 3.5

The fifth hypothesis of the third research question is that there are no differences in the type of packaging material used in 1990 and 1993. Survey question 16¹⁶⁵ asked companies to indicate the type of packaging material utilized within their company in 1990, 1993, and 1996. There were no significant changes in the type of packaging commodity used

165 Survey Question #16:

Please estimate the type of packaging material utilized within your company:

Packaging Commodity	1990	1993	1996
Corrugated/Fiber Boxes	%	%	%
Paper Sacks	%	%	%
Plastic/Rubber containers	%	%	%
Plastic Shrink Wrap	%	%	%
Pallets	%	%	%
Metal	%	%	%
Composites	%	%	%
Other _____	%	%	%
TOTAL	100 %	100 %	100 %

between any of the years. The most extreme change was in the use of plastic/rubber containers where the average use changed from 13.8% of all packaging commodities in 1990 to 16.4% of all packaging commodities in 1996.

Summary:

Accept hypothesis 3.5. There are no differences in the type of packaging material used in 1993 and 1996.

Hypothesis 3.6

The sixth hypothesis of the third research question is that there are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993. Survey questions 9 and 11 used a five point Likert scale to ask companies how solid waste management efforts influenced relationships with suppliers and customers between 1990 and 1993. Survey question 19 asked the companies to indicate how efforts to reduce solid waste modified their relationship with suppliers and customers. Questions 9 and 19 did not have any industry means which were significantly different.

Survey question 9¹⁶⁶ asked the companies to indicate if solid waste management efforts have significantly influenced relationships between customers and suppliers between 1990 and 1993. The 0.267 mean score

166Survey Question #9:

In the last three years, corporate solid waste reduction efforts have significantly influenced relationships between customers and suppliers.

SA - A - N - D - SD

for companies reporting a solid waste management effort was significantly different ($p=0.011$) than the -0.083 mean score of companies reporting they do not have a solid waste management effort. The food and beverage industry had the highest mean response.

Survey question 11¹⁶⁷ asked the company to indicate if they had made a significant effort between 1990 and 1993 to work with suppliers to reduce the amount of secondary and tertiary packaging sent to the company. The 0.618 mean score for the food industry was significantly different than the -0.082 chemical mean score ($p=0.0001$) and the 0.032 electronic ($p=0.0016$) industry mean scores. The 0.473 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0000$) than the -0.500 mean score of companies reporting they do not have a solid waste management effort.

167Survey Question #11:

In the last three years, my company made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

Survey question 19¹⁶⁸ asked the company to identify how solid waste management efforts have modified relationships with suppliers and relationships with customers between 1990 and 1993. Responses were coded using "+1" for "helped us develop a closer working relationship," "0" for "no change," and "-1" for "kept us at an arm's length relationship." A chi-square comparison of the responses indicated a significant difference ($p=0.0000$) for both customers and suppliers.

Summary:

Reject hypothesis 3.6. There are differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts between 1990 and 1993.

Companies with a solid waste management effort were more likely to report working with suppliers to reduce the amount of inbound secondary and tertiary packaging.

Between 1990 and 1993 efforts to reduce solid waste have helped develop closer working relationships with suppliers and customers.

168Survey Question #19:

How have efforts to reduce solid waste over the last three years modified your relationship?

With Suppliers	With Customers	
<input type="radio"/>	<input type="radio"/>	Helped us develop a closer working relationship
<input type="radio"/>	<input type="radio"/>	Kept us at an arm's length relationship
<input type="radio"/>	<input type="radio"/>	No change
<input type="radio"/>	<input type="radio"/>	Not sure
<input type="radio"/>	<input type="radio"/>	Other (please specify)

Hypothesis 4.5

The fifth hypothesis of the fourth research question investigates differences in the type of packaging material used in 1993 and 1996. Survey questions 15 and 16 were used to investigate if companies were redesigning packaging, increasing the number of reusable containers, or changing the type of packaging commodities over time.

Survey question 15¹⁶⁹ asked companies to identify the solid waste management efforts undertaken, or anticipated to be undertaken by the company.

The companies were asked to identify their efforts with suppliers. The percentage of responses indicating increasing the number of reusable containers went up from 37.7% for the time period between 1990 and 1993 to 54.7% projected for the time period between 1993 and 1996

¹⁶⁹Survey Question #15:

Please identify the solid waste reduction efforts (or anticipated efforts) undertaken by your company:

With Suppliers		With Customer		
Between 90 & 93	Between 93 & 96	Between 90 & 93	Between 93 & 96	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reducing the amount of packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Increasing the number of reusable containers
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Redesigning packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Working to better understand packaging needs
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Use of outside consultants
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Other (please specify)

which was a significant difference ($p=0.023$). The percentage of responses indicating the company had redesigned packaging increased from 50.9% for the time period between 1990 and 1993 to 68.6% projected for the time period between 1993 and 1996 which was a significant difference ($p=0.0013$).

The companies were also asked to identify their efforts with customers. The percentage of responses indicating an increase in the number of reusable containers went from 32.1% for the time period between 1990 and 1993 to 42.1% projected for the time period between 1993 and 1996 which was not a significant difference ($p=0.062$) at the 95% confidence interval but may be interpreted as a significant difference at a 93.8% confidence interval. The percentage of responses indicating the company had redesigned packaging with customers increased from 40.9% of the responses for the time period between 1990 and 1993 to 54.7% projected for the time period between 1993 and 1996 which was a significant difference ($p=0.012$).

Survey question 16¹⁷⁰ asked companies to indicate the type of packaging material they utilized, or expect to utilize, in 1990, 1993, and 1996. There were no significant changes in the type of packaging commodity used between any of the years. The most extreme change was in the use of plastic/rubber containers where the average use changed from 13.8% of all packaging commodities in 1990 to 16.4% of all packaging commodities in 1996.

Summary:

Accept hypothesis 4.5. There are no differences in the type of packaging materials used in 1993 and 1996.

Companies will be utilizing the same type of packaging commodity in 1996 as they did in 1990.

Once a commodity is specified to be best for packaging the product, packaging redesign and reuse continues to utilize the same commodity for the package.

170 Survey Question #16:

Please estimate the type of packaging material utilized within your company:

Packaging Commodity	1990	1993	1996
Corrugated/Fiber Boxes	%	%	%
Paper Sacks	%	%	%
Plastic/Rubber containers	%	%	%
Plastic Shrink Wrap	%	%	%
Pallets	%	%	%
Metal	%	%	%
Composites	%	%	%
Other _____	%	%	%
TOTAL	100 %	100 %	100 %

Hypothesis 4.6

The sixth hypothesis of the fourth research question is that there will be no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1993 and 1996. Survey questions 7, 8, 10, and 12 used a five point Likert scale to ask how solid waste management efforts influenced relationships between customers and suppliers. Questions 8, 10, and 12 did not have significant differences between industry means.

Survey question 7¹⁷¹ asked the company to indicate if the procurement function plays a significant role in corporate solid waste management. The 1.038 mean score for companies reporting a solid waste management effort was significantly different ($p=0.064$) than the 0.817 mean score of companies reporting they do not have a solid waste management effort. The 1.200 mean response for the food industry was significantly different than the 0.821 mean response from the chemical industry.

Survey question 8¹⁷² asked the respondents to indicate if they felt it was the role of both the customer and the supplier to actively reduce the

¹⁷¹Survey Question #7:

The procurement function plays a significant role in corporate solid waste reduction.

SA - A - N - D - SD

¹⁷²Survey Question #8:

It is the role of **both** customer and supplier to actively reduce the solid waste stream.

SA - A - N - D - SD

solid waste stream. The 1.3842 mean score of all the responses was the highest mean of any of the Likert questions. The 1.469 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0056$) than the 1.222 mean score of companies reporting they do not have a solid waste management effort. The food and beverage industry had the highest mean response.

Survey question 10¹⁷³ asked the companies to project if corporate solid waste management efforts would significantly influence relationships between customers and suppliers between 1993 and 1996. The 0.939 mean score for companies reporting a solid waste management effort was significantly different ($p=0.0001$) than the 0.458 mean score of companies reporting they do not have a solid waste management effort.

Survey question 12¹⁷⁴ asked the companies if they would be making a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging between 1993 and 1996. The 1.084 mean score for companies reporting a solid waste management effort was

¹⁷³Survey Question #10:

In the next three years, I expect corporate solid waste reduction efforts will significantly influence relationships between customers and suppliers.

SA - A - N - D - SD

¹⁷⁴Survey Question #12:

In the next three years, I expect my company to make a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

significantly different ($p=0.0000$) than the 0.278 mean score of companies reporting they do not have a solid waste management effort. The food and beverage industry had the highest mean response.

The result of the analysis of survey question 7, 8, 10, and 12 leads to the rejection of hypothesis 4.6 that there will be no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts between 1993 and 1996.

Summary:

Reject hypothesis 4.6. Purchasing relationships between customers and suppliers will change between 1993 and 1996 due to packaging solid waste management efforts.

Between 1993 and 1996, companies with a solid waste management effort:

- **Are more likely to believe procurement plays a significant role in solid waste management efforts.**
- **Are more likely to believe solid waste reduction is the role of both the customer and supplier.**
- **Are more likely to develop closer relationships with customers and suppliers.**
- **Are more likely to work with suppliers to reduce secondary and tertiary packaging.**

Trends

Additional comparison of some of the survey questions offer insights to the changing perception of solid waste management from 1990 to 1996.

Question 1¹⁷⁵ asked companies to indicate if there had been a significant change in how the company considered solid waste issues in procurement decisions between 1990 and 1993. Question 2 asked companies to indicate if they felt there would be additional pressure between 1993 and 1996 to consider solid waste issues in the procurement decision. The mean score of 1.224 for question 2 was significantly different ($p=0.0000$) than the mean response of 0.730 for question 1.

Summary:

The amount of pressure to consider solid waste issues in procurement decisions will increase from 1993 to 1996.

175 Survey Question #1:

In the last three years, there has been a significant change in how we consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

Survey Question #2:

In the next three years, I expect additional pressure to consider solid waste issues in our procurement decisions.

SA - A - N - D - SD

Question 4¹⁷⁶ asked companies to indicate if the amount of packaging material used by a supplier was more important in the supplier selection process in 1993 than it was in 1990. Question 5 asked companies to indicate if they felt the amount of packaging material would be more important in 1996 than it was in 1993. The mean score of 1.005 for question 5 was significantly different ($p=0.0000$) than the mean response of 0.415 for question 4.

Summary:

The amount of packaging material used by a supplier will be more important in the supplier selection process from 1993 to 1996 than it was from 1990 to 1993.

176Survey Question #4:

The amount of packaging material used by a supplier is more important now in the supplier selection process than it was in 1990.

SA - A - N - D - SD

Survey Question #5:

The amount of packaging material used by a supplier will be more important in 1996 in the supplier selection process than it is now.

SA - A - N - D - SD

Question 9¹⁷⁷ asked companies to indicate if solid waste management efforts have significantly influenced relationships between customers and suppliers between 1990 and 1993. Question 10 asked companies to indicate if they felt solid waste management issues would significantly influence relationships between customers and suppliers between 1993 and 1996. The mean score of 0.770 for question 10 was significantly different ($p=0.0000$) than the mean response of 0.147 for question 9.

Summary:

Corporate solid waste management efforts will influence relationships between customers and suppliers more between 1993 and 1996 than they did between 1990 and 1993.

¹⁷⁷Survey Question #9:

In the last three years, corporate solid waste reduction efforts have significantly influenced relationships between customers and suppliers.

SA - A - N - D - SD

Survey Question #10:

In the next three years, I expect corporate solid waste reduction efforts will significantly influence relationships between customers and suppliers.

SA - A - N - D - SD

Question 11¹⁷⁸ asked companies to indicate if they had made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to the company between 1990 and 1993. Question 12 asked companies to indicate if they felt they would make a significant effort to reduce the amount of secondary and tertiary packaging sent to the company between 1993 and 1996. The mean score of 0.804 for question 12 was significantly different ($p=0.0000$) than the mean response of 0.137 for question 11.

Summary:

Efforts to work with suppliers to reduce the amount of secondary and tertiary packaging will increase between 1993 and 1996.

The mean responses for the chemical and electronics industries were substantially lower than the mean responses for the food and beverage industry for questions 1, 4, 9, and 11. These questions dealt with the time period between 1990 and 1993. The food and beverage industry as a whole has been more active in packaging solid waste management efforts

¹⁷⁸Survey Question #11:

In the last three years, my company made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

Survey Question #12:

In the next three years, I expect my company to make a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.

SA - A - N - D - SD

than the chemical and electronics industries. The mean responses for all industries were much similar for questions 1, 5, 10, and 12 suggesting the chemical and electronics industries will be much more active in their packaging solid waste management efforts in 1993 and 1996.

Summary:

The food and beverage industry has been more active in packaging solid waste management efforts between 1990 and 1993. The chemical and electronics industries will be much more active in their packaging solid waste management efforts between 1993 and 1996.

Other Findings

Question 13¹⁷⁹ asked companies to indicate how much more they would pay for packaging that could be reused two, five, and ten times compared to the cost of one-time use packaging. The results for all responses indicated companies would be willing to pay an average of 12% more for packaging material which could be reused two times, 29% more for packaging that could be reused five times, and 55.6% more for packaging which could be reused ten times.

¹⁷⁹Survey Question #13:

Please indicate how much more your company would be willing to pay for packaging which could be reused compared to one-time use packaging.

Number of times packaging may be re-used		
Two Times (2X)	Five Times (5X)	Ten Times (10X)
%	%	%

Separating the results by industry resulted in clear differences in the acceptability of reusable packaging. These findings were supported by unsolicited comments written by the respondents on the survey. Respondents from the food and beverage industry indicated they would be willing to pay the smallest premium for reusable packaging. Many of the comments from these respondents cited health and contamination concerns. Respondents from the chemical industry indicated they would be willing to pay the highest premium of any of the industry groups for reusable packaging. The mean responses from the electronics industry fell between the mean responses of the food and beverage industry and the chemical industry. Many of the comments from these respondents cited concerns of the presence of static electricity on reusable packaging.

Summary:

The chemical industry is more likely to pay a premium for reusable packaging. The electronics and food and beverage industries are less likely to pay a premium for reusable packaging due to concerns about contamination on the packaging.

Summary of Mail Survey Results

The analysis of the mail survey as the questions relate to the research hypotheses has been summarized in Table 23. The details of the analysis can be found in Appendix C.

1. A significant number of respondents reported that they had an "on-going" solid waste effort. The food and beverage industry and the chemical industry had significantly more respondents reporting an "on-going" effort.
2. Integration of a solid waste reduction effort into procurement procedures is not dependent on having a formal, documented effort.
3. Companies are more likely to share their solid waste reduction efforts with suppliers if the effort has been integrated into purchasing procedures.
4. Companies are more likely to share their solid waste reduction efforts with suppliers if the solid waste reduction effort is formal and documented.
5. There was no significant difference between survey responses from participants with less than three years in their current position and responses from participants with three or more years in their current position..
6. The purchasing organizational structure has been modified to support solid waste management efforts in 1990 and 1993.
7. The skills required by purchasing to support packaging solid waste management efforts changed between 1990 and 1993.

8. The purchasing "buy" decision has been influenced by packaging solid waste management efforts between 1990 and 1993.
9. There has been a significant change in how we consider solid waste issues in procurement decisions.
10. The amount of packaging material used by a supplier is considered by those companies with a solid waste management effort.
11. The amount of packaging material used by a supplier is more important in 1993 than it was in 1990.
12. There has been no difference in the time it takes to make a sourcing decision which supports packaging solid waste efforts in 1990 and 1993.
13. There has been a difference in the complexity of the sourcing decisions supporting packaging solid waste efforts between 1990 and 1993.
14. There will continue to be changes to the purchasing organizational structure to support packaging solid waste management efforts between 1993 and 1996.

15. There will be additional pressure to consider solid waste issues in procurement decisions. The amount of packaging material used by a supplier will be more important in 1996 than it was in 1993 for all companies in general and it will be more important to companies with solid waste management efforts than to those without solid waste management efforts.
16. There will be a difference in the time it takes to make a sourcing decision which supports packaging solid waste efforts between 1993 and 1996. The difference in the sourcing time will affect companies regardless of whether they have a solid waste management effort.
17. There will be a difference in the complexity of sourcing decisions which support packaging solid waste efforts between 1993 and 1996. The difference in the sourcing complexity will affect companies regardless of whether they have a solid waste management effort.
18. Weight and volume of primary, secondary, and tertiary inbound and outbound packaging material was reduced between 1990 and 1993. There will continue to be improvements to weight and volume of primary, secondary, and tertiary inbound and outbound packaging material between 1993 and 1996.

19. Between 1990 and 1993, companies with a packaging solid waste management effort had greater reductions of the weight of primary packaging material received from suppliers than those companies without a solid waste management effort. A trend which likely will continue between 1993 and 1996.
20. There are no differences in the type of packaging material used in 1993 and 1996.
21. There are differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts between 1990 and 1993.
22. Companies with a solid waste management effort were more likely to report working with suppliers to reduce the amount of inbound secondary and tertiary packaging.
23. Between 1990 and 1993 efforts to reduce solid waste have helped develop closer working relationships with suppliers and customers.
24. There are no differences in the type of packaging materials used in 1993 and 1996.
25. Companies will be utilizing the same type of packaging commodity in 1996 as they did in 1990. Once a commodity is specified to be best for packaging the product, packaging redesign and reuse continues to utilize the same commodity for the package.

26. Purchasing relationships between customers and suppliers will change between 1993 and 1996 due to packaging solid waste management efforts.
27. The amount of pressure to consider solid waste issues in procurement decisions will increase from 1993 to 1996.
28. The amount of packaging material used by a supplier will be more important in the supplier selection process from 1993 to 1996 than it was from 1990 to 1993.
29. Corporate solid waste management efforts will influence relationships between customers and suppliers more between 1993 and 1996 than they did between 1990 and 1993.
30. Efforts to work with suppliers to reduce the amount of secondary and tertiary packaging will increase between 1993 and 1996.
31. Between 1993 and 1996, companies with a solid waste management effort:
 - Are more likely to believe procurement plays a significant role in solid waste management efforts.
 - Are more likely to believe solid waste reduction is the role of both the customer and supplier.

- Are more likely to develop closer relationships with customers and suppliers.
- Are more likely to work with suppliers to reduce secondary and tertiary packaging.

32. The food and beverage industry has been more active in packaging solid waste management efforts between 1990 and 1993. The chemical and electronics industries will be much more active in their packaging solid waste management efforts between 1993 and 1996.

33. The chemical industry is more likely to pay a premium for reusable packaging. The electronics and food and beverage industries are less likely to pay a premium for reusable packaging due to concerns about contamination on the packaging.

Table 23

Summary of Hypothesis Acceptance or Rejection

Hypothesis

- | | | |
|--------|-----|---|
| Reject | 1.1 | There are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and 1993. |
| Reject | 1.2 | There are no differences in the skills required by purchasing to support packaging solid waste management efforts in 1990 and 1993. |
| Reject | 1.3 | There are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993. |
| Accept | 1.4 | There are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993. |
| Reject | 1.5 | There are no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993. |

Table 23 (Continued)

Hypothesis

- Reject 2.1** There will be no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1993 and 1996.
- Reject 2.2** There will be no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1993 and 1996.
- Reject 2.3** There will be no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.
- Reject 2.4** There will be no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.

Table 23 (Continued)

		Hypothesis
Reject	3.1	There are no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.2	There are no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.3	There are no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.4	There are no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Accept	3.5	There are no differences in the type of packaging material used in 1990 and 1993.
Reject	3.6	There are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993.

Table 23 (Continued)

		Hypothesis
Reject	4.1	There will be no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.2	There will be no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.3	There will be no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.4	There will be no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Accept	4.5	There will be no differences in the type of packaging material used in 1993 and 1996.
Reject	4.6	There will be no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1993 and 1996.

STAGE TWO: CASE STUDIES

After the mail surveys were conducted, the second stage of the research methodology was conducted. The final question of the survey asked companies to indicate if they would be willing to participate further in a field case study. A total of thirty companies offered further involvement, with 14 from the chemical industry, 9 from the electronics industry, and 7 from the food and beverage industry.

The thirty companies were grouped by geographic region in an attempt to minimize the amount of travel required to conduct the case studies. The list was reduced by selecting companies in the geographic areas around Boston, Philadelphia, and Raleigh-Durham. The initial plans of the researcher were to make all of the case studies on-site visits and to minimize travel costs. A summary of preliminary survey results was mailed with a cover letter to the companies selected. The cover letter was used as a reminder of their offer to participate in a field case study and indicated that the researcher would be calling on a specific date to discuss the details of a potential case study.

Each company was contacted by telephone and screened to determine if the case study would provide sufficient information beyond that of the mail survey. An outline of the case study process and potential visit dates were discussed. The screening process eliminated one electronics company and two food companies. One company suggested conducting a case study using the telephone and offered to send a package of documents prior to the case study. The researcher had previously been

employed by the company and had sufficient confidence with using this method.

Two of the three food companies initially selected were eliminated during pre-screening. In an attempt to find a case study company in the food and beverage industry which was within close proximity to the researcher's location, the researcher contacted a packaging consultant who offered the names of client companies which might be willing to take part in a case study. The first company contacted was willing to participate.

One of the companies asked not to be identified by name. Each company case study has been coded as Company "A - G" to fulfill this request.

The case studies were used to investigate how companies have approached solid waste management efforts in the supply chain. The original research methodology proposed only four case studies to investigate how companies handled the flow of packaging material into and out of the case study company. Seven case studies were actually conducted to ensure both the supplier and the customer portions of the supply chain were covered in the case studies.

The case studies ran in duration from a two hour telephone call using supporting documents which were mailed ahead of time to eight hours in duration. An interview protocol was utilized to guide the interviewer through each case study. A copy of the interview protocol is in Appendix D. After each case study was completed, a summary of the

case study was written and a facsimile was sent to the case study contact person to review for correctness. A description of each company studied and the company approved case study write-up is in Appendix E.

The following represents multiple responses from case study interviews which identify common threads found during the case studies.

Solid Waste Motivations

Question:

Why did your company start doing something about packaging solid waste?

Response Number 1:

We are motivated by the following:

1. Proposed legislation
2. Activities in the international arena
3. A few customers requesting action on our part

In future we expect:

- Some states will push for more legislation
- There will be an increased emphasis to reduce waste coming from:
 - Customers as their landfill costs increase
 - Suppliers as they wake up to the opportunities
- CONEG is moving toward a reasonable joint effort by working with industry

Response Number 2:

As a chemical company, we are very much in the public eye. My company publishes an annual environmental report to stockholders. In the past we have concentrated on air and water pollutants but have recently expanded the scope of our effort to solid waste reduction.

Response Number 3:

Our environmental efforts started in 1974 and incorporated customers and suppliers. It originated as a Distribution Competency Center to support distribution engineering and packaging engineering to lower costs.

Response Number 4:

Our solid waste reduction efforts started as a result of state reporting requirements. Any company generating more than two thousand pounds of any specific type of waste is required to provide a bi-annual report documenting what we put into the solid waste stream and where it goes after we put it in. Our waste hauler must also file the report and get approval for the disposal of our waste. Our waste ended up being classified as "municipal-like" so we have been able to avoid costly chemical analysis but we still must report bi-annually.

Response Number 5:

We started reducing our packaging as a means of reducing overall costs. The food industry is very cost competitive and any advantage which can be found will be taken advantage of. The positive impact to the environment and solid waste reduction for the company was a secondary benefit. The green movement came through our industry two or three years ago

and was driven through the retail markets. We expect the movement to resurface and become more of a concern as more customers ask about it and government regulations require changes.

Response Number 6:

Our Swiss parent is a chemical company which is very environmentally conscious. Although our business is electronics, the same corporate ground rules hold. The desire to be a "green" company has permeated throughout the entire corporation. In addition, local landfill costs have more than doubled over the last three years. Finally, many of our customers are in the food industry and reduced packaging is sometimes a part of the specified requirements to do business with these companies.

Response Number 7:

Our efforts are driven through the manufacturing operations to meet our European market requirements. Also, our products are shipped by air, our air shipments cube out before they weight out, so we have economic reasons to reduce packaging materials on all international shipments.

Lessons Learned:

The motivation to reduce packaging solid waste comes from many different areas. The primary reasons cited include cost avoidance, government regulation, and company culture .

Table 24
Motivations To Manage Solid Waste

	Primary Motivation(s)			
	Cost Avoidance	Government Regulations	Company Culture	Personal Feelings
Chemical "A"				X
Chemical "B"		X	X	
Electronic "C"	X	X		
Electronic "D"	X		X	
Food/Beverage "E"	X	X		
Electronic "F"	X		X	
Food/Beverage "G"	X			

Purchasing Operations

Question:

What is the role of purchasing in the overall corporate packaging solid waste reduction effort?

Response Number 1:

Purchasing is involved as a part of the overall supply chain management group. We have centralized sourcing and de-centralized buying so it is our corporate purchasing operation that sets up the sources.

Response Number 2:

Purchasing acts as a facilitator to meet our corporate guidelines. They interact with our suppliers and solicit their involvement in the solid waste reduction effort. In a recent case, Purchasing was asked to come in to help resolve an environmental disposal issue with a supplier.

Response Number 3:

Purchasing operations are supported through a corporate packaging competency center. We establish centralized packaging and material handling specifications which are then implemented by purchasing at each site.

Response Number 4:

Purchasing offers the natural link to suppliers and use of their programs. Specific purchasing departments have made solid waste reduction a part of the buyer performance plan.

Lessons Learned:

The role of Purchasing for the case study companies has been primarily supportive to implement centralized solid waste reduction efforts.

Setting Reduction Goals**Question:**

How did you determine your solid waste reduction goals?

Response Number 1:

We took the EPA proposed targets and doubled them.

Response Number 2:

A goal was set to reduce what ultimately goes into landfills by 50% by the year 2000 using 1991 as a base year. We set up interim reduction targets for 1995 and 1998 to help us stay on track. The measurement of the reduction is extremely difficult. We are taking into consideration every effort taken to reduce what ultimately goes into the landfill including efforts of reducing what comes into our company as well as tracking what happens to the packaging materials after they leave our company.

Table 25

Centralization/Decentralization of Sourcing/Buying Activities

	Sourcing		Buying	
	Centralized	Decentralized	Centralized	Decentralized
Chemical "A"	X		X	
Chemical "B"	X			X
Electronic "C"	X			X
Electronic "D"	X		X	
Food/Beverage "E"		X		X
Electronic "F"		X		X
Food/Beverage "G"	X			X

Table 26

How Companies Set Solid Waste Reduction Goals

	No Specific Goal	"Gut" Feel	Conservative Estimate	Detailed Analysis
Chemical "A"	X			
Chemical "B"		X		
Electronic "C"		X		
Electronic "D"	X			
Food/Beverage "E"			X	
Electronic "F"	X			
Food/Beverage "G"				X

Response Number 3:

Efforts are determined and championed at each manufacturing plant. Purchasing does not have specific goals that they are trying to meet or trying to support. Our state government does suggest a voluntary reduction goal of 5% per year.

Response Number 4:

We are required by the state to provide a five year plan solid waste reduction plan and have it available on request. So far no one has requested it but we have started putting the plan into effect. As a part of our five year plan, our corporate committee created a corporate solid waste mission statement. We started conducting quarterly audits of the content of our solid waste by department early in 1992. We originally set "realistic but conservative" solid waste reduction goals for our five year reduction plan and were pleasantly surprised that we have dramatically exceeded our goals.

Response Number 5:

Our packaging consultant looked at 2000 Stock Keeping Units and initially selected 12 to install pilot packaging changes. After an overall analysis, the consultant recommendations essentially became our goals.

Response Number 6:

There are no specific, quantifiable corporate solid waste reduction goals. It is a part of our corporate culture.

Lessons Learned:

Corporate solid waste reduction goals tend to be set with little hard analysis.

Involvement in the Supply Chain**Question:**

When setting up a program, how do you motivate the supplier/customer to come on board

Response Number 1:

Our solution involves the entire supply chain. If we cannot get our suppliers and customers on-board, we find we have difficulties which we cannot overcome. We conducted meetings with our suppliers to analyze the amount of packaging material used to ship product to us and how we receive product resulting in a series of changes over time to reduce over-packaging. As packaging was modified, each change (such as adding dividers, shrink wrapping, or using special glues) was added on its own merits and either increased the amount of packaging material shipped or complicated the potential of the packaging. The effort to reduce packaging material has been a joint effort and has been well received by suppliers.

We have been very responsive to requests from our customers to modify our packaging. Although our primary customers are the distributors and retail outlets that sell our products, we also solicit and act on the opinions of the final consumer.

Response Number 2:

We are implementing an Alternate Sourcing program to increase the amount of competition in our supplier base. A side benefit is that we are now asking for more technical input from our suppliers earlier. The free market and increased competition is working to help achieve improvements. Suppliers realize they must be more involved in the overall operation to earn our business.

Response Number 3:

Due to the technical nature of our products, customers often communicate technical requirements and feedback directly to the manufacturing location. Occasionally special packaging is communicated directly to Shipping as an order qualifier.

We have encouraged suppliers to take back as many pallets as they want regardless of the number they originally shipped to us. We have also found the suppliers are a good source of disposal information, if only we remember to ask.

We have a philosophy to be "the best customer to a shrinking number of suppliers." We try to work closely with our suppliers to make improvements that are jointly beneficial. We have one case where we made a change to the packaging and the supplier ultimately made three additional improvements after we got the ball rolling.

Response Number 4:

We are dependent on Marketing to go out and sell the program to our customers. Unfortunately Marketing is not interested in doing this right now, though I expect it will be in the future. We considered utilizing a more expensive reusable container but backed off when our customers balked at the price increases we were going to pass on to them.

We have not considered inbound packaging.

Response Number 5:

We have the technical expertise through our Packaging Competency Center to provide the best packaging design for our inbound packaging from suppliers and for our outbound packaging to customers. They are accepting of our skill base.

Lessons Learned:

Case study companies are involving adjoining channel members to reduce packaging solid waste. The joint efforts allow for shared expertise and mutually agreeable improvements.

Table 27

Involvement of Suppliers and Customers in Solid Waste Reduction Efforts

	Effort With:		
	Supplier	Internal	Customer
Chemical "A"		X	X
Chemical "B"	X	X	X
Electronic "C"	X	X	X
Electronic "D"		X	X
Food/Beverage "E"	X	X	X
Electronic "F"	X	X	X
Food/Beverage "G"		X	X

Table 28

Purchasing Involvement in Solid Waste Reduction Efforts

	Direct	Support
Chemical "A"	X	
Chemical "B"		X
Electronic "C"		X
Electronic "D"		X
Food/Beverage "E"		X
Electronic "F"		X
Food/Beverage "G"		X

Purchasing Involvement

Question:

Who in Purchasing is responsible for the packaging solid waste reduction effort?

Response Number 1:

The Manager of Packaging Purchasing has made it her responsibility for packaging solid waste efforts but it is not formally recognized within the organization chart. It is part of her subjective definition of what the department should be doing. The results are not formally reported to upper management as there is a general "lack of interest" by our executives which will not change unless there is a financial penalty or our customers start calling for waste reduction efforts. Neither is happening so this is perceived as just another thing to track.

Response Number 2:

Purchases are driven by corporate packaging guidelines. We have also set up a Corporate Environmentally Improved Packaging Program to support our corporate efforts. The program has set up guidelines and provides support to help lightweighting of packaging materials, expanding closed loop partnerships with customers and package suppliers, and registering qualifying packaging for German return systems.

Response Number 3:

It is the role of every buyer, as a part of our corporate culture, to be responsible for the environmental aspects of whatever they are buying.

Response Number 4:

As a food producer, we have a Superintendent of Environmental Sanitation who oversees solid waste reduction efforts. We also utilize a corporate committee to address the effort.

Response Number 5:

Solid waste reduction responsibility comes through the designs originating at the packaging competency center.

Response Number 6:

Due to severe manpower constraints we opted to have an outside consultant work on packaging improvements.

Lessons Learned:

Purchasing plays a supportive role in solid waste reduction efforts.

Purchasing Skills**Question:**

Has the packaging solid waste reduction effort required new or unique procurement skills?

Response Number 1:

No special skills are required but Buyers must have a thorough knowledge of current legislation.

Response Number 2:

We are focusing our training on the awareness of the issues, current regulatory issues/requirements, company policies/goals, what has been accomplished, and how the company benchmarks against other companies. We also need to develop leadership and team building skills.

Response Number 3:

We use an in-house consultant to provide support for solid waste reduction efforts and meeting EPA requirements. We need to develop our purchasing skills to become technically competent so we know what questions to ask and to be able to correctly and effectively assess the responses.

Response Number 4:

Due to manpower constraints, we chose to utilize a packaging consultant who has the expertise and the time to spend improving our packaging so we can spend our time working on other activities. It has been money well spent as we have achieved significant cost savings.

Lessons Learned:

All companies agreed there is a need for awareness of the issues, an understanding of current and projected environmental legislation affecting the company, and current corporate efforts.

Table 29

Purchasing Skills Needed To Support Solid Waste Reduction Efforts

	Awareness	Personal Skills	Outsourced Consultant
Chemical "A"	X		
Chemical "B"	X	X	
Electronic "C"	X	X	
Electronic "D"	X		
Food/Beverage "E"	X		
Electronic "F"	X	X	X
Food/Beverage "G"	X		X

"Awareness" includes current and projected legislative rulings and knowledge of corporate efforts.

"Personal Skills" cited include developing leadership and team building skills.

"Outsourcing" included using an in-house consultant or a third-party consultant

Table 30

How Purchasing Supports Solid Waste Reduction Efforts

	Competency Center or Consultant	Packaging Group	Environmental Council or Committee
Chemical "A"		X	
Chemical "B"	X	X	X
Electronic "C"	X	X	X
Electronic "D"			X
Food/Beverage "E"			X
Electronic "F"	X		X
Food/Beverage "G"	X		

Table 31

How Purchasing Is Involved With Customers

	Avoid	Share In-formation	Integrated Solution	Track Customer Effort
Chemical "A"	X			
Chemical "B"		X	X	X
Electronic "C"		X	X	
Electronic "D"			X	
Food/Beverage "E"			X	
Electronic "F"		X	X	
Food/Beverage "G"		X	X	

Organizational Changes

Question:

What organizational changes have taken place within Purchasing to accommodate packaging solid waste management efforts.

Response Number 1:

We set up a centralized corporate packaging competency center.

Response Number 2:

Our packaging group is a sister group to Purchasing in Materials Management. It was a natural development to link the two together in Packaging Purchasing but did not occur as a result of efforts to reduce solid waste.

Response Number 3:

Up until two and half years ago we only had a single person to handle corporate purchasing. We now have three people and they can spend more time doing the up front work. We were under time and manpower constraints and tended to source in a haphazard manner. We are now starting an Alternate Sourcing program to increase supplier competition as a means to reduce overall costs. More effort up front will pay off in the long run. We expect to continue growing and so we now pay a consultant an annual retainer to work on packaging reduction.

Response Number 4:

Purchasing utilizes an environmental "council team" of buyers, engineers, and support personnel to address environmental issues.

Lessons Learned:

Case study companies have not reorganized as a result of solid waste reduction efforts but often seek assistance from other functions within the company. Purchasing is frequently represented on corporate environmental committees.

Involvement with Customers**Question:**

How does Purchasing get involved in reducing packaging material which ultimately will go to your customers?

Response Number 1:

Purchasing operations are supported through a corporate packaging competency center. We establish centralized packaging and material handling specifications which are then implemented by purchasing at each site.

Response Number 2:

Our consultant considers the entire supply chain in his analysis and involves the customer in any changes.

Response Number 3:

A recent success in our overall packaging scheme was the implementation of reusable packaging coming from our supplier which we then use to ship our final product. We designed inbound packaging specifications and determined an acceptable source of the packaging material for our supplier

to use. After they ship the shell of our product, we can reuse the packaging to ship the final product to our customer.

Response Number 4:

We do not get involved with our customer's disposal of packaging material because we are concerned the customer would ask us to foot the bill for disposal. We do offer a realistic list of disposal options for our customers to pursue.

Lessons Learned:

Case study companies generally integrate customers in packaging solid waste reduction effort.

Measuring Reduction Efforts

Question:

How are the Purchasing solid waste reduction efforts measured?

Response Number 1:

We have tried to track outbound packaging but have found it to be too difficult to collect meaningful data. We do not really know what the overall effect is to switch to an IBC in terms of how much packaging waste is reduced. The same holds for recycled/reused pallets. Subsequently we have not been very successful in our business cases.

Response Number 2:

Since this is part of our corporate culture we do not have formal measurements in place.

Response Number 3:

There are no specific purchasing measurements as it is a part of our corporate culture.

Response Number 4:

Our purchasing efforts are not measured. We have a problem identifying how much of supplier overhead is packaging related.

Response Number 5:

We are currently developing an executable computer file to facilitate the reporting process. Each location currently manually collects the data and reports it for compilation.

Response Number 6:

Our initial measurement efforts are focused on reducing what we send out to our customers. We will shortly begin precisely measuring what comes in terms the quantity and recycled content of the materials. Our reduction effort will be based on estimates of what came into our company in 1991. We are also trying to project and incorporate the recycled content level our packaging suppliers can expect to offer us in 1995 and 2000.

Table 32

How Solid Waste Reduction Efforts Are Measured

	No Tracking	Manual Tracking	Computerized Tracking
Chemical "A"	X		
Chemical "B"		X	X
Electronic "C"		X	X
Electronic "D"	X		
Food/Beverage "E"		X	
Electronic "F"	X		
Food/Beverage "G"	X		

Table 33

How Sourcing Complexity Has Changed

	Less Complex	One Time Hit	More Complex
Chemical "A"		X	
Chemical "B"			X
Electronic "C"	X		
Electronic "D"			X
Food/Beverage "E"		X	
Electronic "F"			X
Food/Beverage "G"			X

We are developing an internal reporting system to understand the flow of packaging material and the sources of reusable materials. We are also trying to expand the scope of the measurement program to determine what happens to the material after it goes to the customer.

Lessons Learned:

Measurement and tracking of reduction efforts is very difficult. Case study companies reported problems determining what to use as the base, what to measure, and how to effectively measure changes.

Sourcing Complexity

Question:

How has packaging solid waste reduction impacted the complexity of your sourcing decision?

Response Number 1:

Our relationships with our suppliers and our customers have become closer over the years due to many factors including our joint efforts on environmental issues. We see it as very important to have a close working relationship with your suppliers to achieve the desired reductions. Our long term efforts include reducing our supplier base from 900 suppliers to 200 suppliers over the next 18 months so we can have closer working relationships with fewer suppliers.

Response Number 2:

We have a philosophy to be "the best customer to a shrinking number of suppliers." We try to work closely with our suppliers to make improvements that are jointly beneficial.

Response Number 3:

Our packaging competency center has simplified the purchasing effort.

Response Number 4:

Our sourcing activities have intentionally become more complex as a result of our Alternate Sourcing program. We are intentionally adding suppliers as a means of achieving competitive cost reductions and we are asking them for more technical information.

Response Number 5:

We have been reducing our supplier base as part of our overall Deming approach to business but our reduction efforts have not been waste driven.

Lessons Learned:

Case study companies report working closer with their suppliers.

Reduction Efforts

Question:

What alternatives have been explored to reduce packaging solid waste?

Response Number 1:

The packaging competency center investigates all aspects of packaging reduction, reuse, and recycling opportunities. We also have an annual internal packaging competition to encourage corporate locations to improve their packaging efforts.

Response Number 2:

We are trying to incorporate the 3R's (Reduce, Recycle, and Reuse) plus a 4th "R" to buy recycled materials whenever possible. Our efforts include lightweighting, using self-destructing packaging, removing heavy metals, utilizing bulk or semi-bulk shipments, promoting reuse through development of a returnable packaging system, working on design modifications for recyclability and developing customer/supplier relationships.

Our initial efforts involve working with our thirty top customers. These customers represent 50% of the total volume of packaging material used by the company. Our pilot program hopes to determine the scope and magnitude of the reduction task, determine return channel needs, and identify potential leverage points to help achieve our reduction goals.

Response Number 3:

We have found local suppliers are more likely to take back packaging material, primarily because they use their own trucking which helps support our effort to source locally.

We have a standing request to our printer to notify us when it becomes economically feasible to print on recycled paper.

Since we ship to the European markets, we realize we must be prepared to pay for the return of the vinyl binder used to hold product documentation. We are looking for alternatives such as using a hard paper cover or shipping the documentation using a software diskette.

Response Number 4:

We have been able to use our own internal trucking network to reuse cardboard within our own company. We reuse corrugated packaging approximately 11 times. We also utilize reusable plastic anti-static containers. Our dedicated truck visits each plant twice a week so we have a closed operating loop.

Our design process includes a step where a steering committee reviews the design to "confirm the environmental impact...and to address and resolve any [environmental] issues."

Response Number 5:

Our consultant considers the effect of all types of packaging changes from a total cost perspective. The analysis considers the impact to packaging, transportation, and warehousing costs.

Response Number 6:

There are limited alternatives which have been explored. As a matter of practice, we lightweight our drums whenever possible although we have had some customers request a heavier container for business reasons.

We have looked into reuse and refill of IBC containers. A return mechanism is lacking so high return freight costs eliminate consideration of this practice.

We look to third parties for development of solutions. We might consider refilling containers if the return mechanism were there but generally we do nothing else other than to support and promote outside solutions.

Response Number 7:

Sometimes our alternatives are resolved through simple economics. We had a case where the closest company willing to accept a specific waste material for retromanufacturing was located 1,400 miles away. It was not economically feasible to accumulate the amount of material required to economically ship to this company. Even when we had accumulated enough material, the transportation cost to send the material costs approximately \$1,900 for 15 tons. Our alternative is to landfill the mate-

rial at an equivalent cost of \$975. Unless we have a closer outlet to ship this material, our best economical solution is to landfill the waste.

Lessons Learned:

There are a number of reduction possibilities available but few companies are willing go out and develop the infrastructure to support more solutions.

The overriding factor in considering alternatives is the total cost including unit price and disposal costs..

Companies are more likely to avoid bring material into the company. Recycling is also popular, largely because of high visibility.

Table 34

Corporate Solid Waste Reduction Efforts

	Reduce	Reuse	Recycle	Use Recycled
Chemical "A"	X		X	
Chemical "B"	X	X	X	X
Electronic "C"	X	X	X	X
Electronic "D"	X		X	X
Food/Beverage "E"	X		X	
Electronic "F"	X	X	X	X
Food/Beverage "G"	X		X	X

Business Cases

Question:

Have any recent business cases been conducted which involve packaging or solid waste reduction efforts?

Response Number 1:

Our consultant utilizes an optimization program to identify a number of scenarios which we can follow. Each scenario trades off the relationships of each component in the distribution channel, the design mode, arrangement patterns used, appropriate case counts, the amount of necessary slack (length and width), allowable vertical dimensions, pallet patterns and effective strength for various options (such as use of an interlocking pattern or a combination of a column plus shrink wrap), opportunities for alternative packaging (such as use of a slip sheet instead of a pallet), allowable pallet overhang, allowable stack height throughout the entire distribution channel, appropriate use of dividers, and optimal utilization of flaps and corners to add strength to the packaging.

Response Number 2:

Other than our initial reduction goal, we are trying to get a handle on the measurements so we can develop meaningful business cases to guide our decisions.

Response Number 3:

Measurement of improvement comes from tracking the reduction in waste disposal costs. Solid waste removal costs \$0.0325 per pound and alternative removal cost of pre-sorted commodities runs \$0.01 per pound. While

the audit determines we can do a better job of sorting out our waste, we have reduced our annual solid waste removal costs by \$1,778. We were surprised to discover that when we used a cost per pound metric, the most expensive component of our finished product is the packaging material.

Response Number 4:

Consideration of potential alternatives originated when someone tried to justify buying a baling machine to bale our corrugated. Someone suggested we look for reuse or reduction alternatives so we wouldn't need the baler.

Response Number 5:

We have not conducted a formal business case for our recycling program but I know the disposal cost for sorted papers and glass is about half of the cost to dispose of unsorted waste.

Response Number 6:

Our environmental decisions are not always financially driven as we have a corporate philosophy of wellness and greenness that pervades the decision making process.

Response Number 7:

Our business cases have been failures because we are not able to effectively incorporate meaningful cost improvements of proposed changes.

Lessons Learned:

The use of business cases are subject to the availability of valid data and whether they are encouraged by the corporate culture.

Difference From Other Companies or Industries**Question:**

Do you feel your industry or company is different from others in addressing packaging solid waste?

Response Number 1:

Comparing the chemical industry with Food/Beverage and Electronics, I would say the other industries are doing more because they are consumer products and there is a greater emphasis in the consumer products area. Besides, all legislation seems to be targeting consumer packaging.

Response Number 2:

A number of our suppliers have indicated this is the first time solid waste reduction has been mentioned to them by an (electronics) customer indicating to us that we are out in front of the effort, at least with regard to the other companies utilizing the same suppliers.

Response Number 3:

We are very open with our customers and suppliers by providing extensive documentation for their own improvements. It is not unusual that we have far more information that they do.

Table 35

Formality of Solid Waste Management Business Cases

	Formal	Informal
Chemical "A"		X
Chemical "B"	X	
Electronic "C"	X	
Electronic "D"		X
Food/Beverage "E"	X	
Electronic "F"	X	
Food/Beverage "G"	X	

Lessons Learned:

Corporate solid waste reduction efforts are in their infancy.

What Companies Would Have Done Differently**Question:**

What would you do differently if you could do it over again?

Response Number 1:

I would consider dedicating more time to this area. It is difficult to do on a proactive basis because you are waiting for others to come up with solutions and there is a general lack of emphasis. When we get into a reactive fire fighting mode the issue will get far more attention.

Response Number 2:

Given the cost effective success of our efforts, we should have considered working on solid waste reduction long before we were required to do so by the state government.

Response Number 3:

In hindsight, we should have gone out to the universities with strong packaging programs and hired a full time employee. The cost savings have been significant and would have easily paid for the burdened salary; plus we probably could use the employee for other activities as well as we continue to grow.

Table 36

What Companies Would Have Done Differently To Manage Solid Waste

	Started Earlier	Properly Staffed	Better Supplier Selection
Chemical "A"	X		
Chemical "B"	X		
Electronic "C"			
Electronic "D"			X
Food/Beverage "E"	X		
Electronic "F"	X		X
Food/Beverage "G"	X	X	

Response Number 4:

We would have acted sooner and selected more suppliers that are moving in the same environmental direction as we are.

Lessons Learned:

Most of the case study companies indicated they wished they had started their efforts sooner. Other comments suggest heightened awareness would have helped guide some of the earlier decisions on staffing and supplier selection.

Summary of Case Studies

The case studies offered insights to the variety of approaches to packaging solid waste management efforts. The common findings include:

1. The motivation to reduce packaging solid waste comes from many different areas. The primary reasons cited include cost avoidance, government regulation, and company culture.
2. The role of Purchasing for the case study companies has been primarily supportive to implement centralized solid waste reduction efforts.
3. Corporate solid waste reduction goals tend to be set with little hard analysis.
4. Case study companies are involving adjoining channel members to reduce packaging solid waste. The joint efforts allow for shared expertise and mutually agreeable improvements.

5. Purchasing is playing primarily a supportive role in solid waste reduction efforts.
6. All companies agreed there is a need for awareness of the issues, an understanding of current and projected environmental legislation affecting the company, and current corporate efforts.
7. Case study companies have not reorganized as a result of solid waste reduction efforts but often seek assistance from other functions within the company. Purchasing is frequently represented on corporate environmental committees.
8. Case study companies generally integrate customers in packaging solid waste reduction effort.
9. Measurement and tracking of reduction efforts is very difficult. Case study companies reported problems determining what to use as the base, what to measure, and how to effectively measure changes.
10. Case study companies report working closer with their suppliers.
11. There are a number of reduction possibilities available but few companies are willing to go out and develop the infrastructure to support more solutions.

The overriding factor in considering alternatives is the total cost.

Companies are more likely to avoid bring material into the company. Recycling is also popular, largely because of high visibility.

12. The use of business cases are subject to the availability of valid data and whether they are encouraged by the corporate culture.

13. Corporate solid waste reduction efforts are in their infancy.

14. Most of the case study companies indicated they wished they had started their efforts sooner. Other comments suggest heightened awareness would have helped guide some of the earlier decisions on staffing and supplier selection.

Summary

Chapter Four has presented the results of the research project. The purchasing organization has been affected by corporate solid waste efforts and the research suggests there will be a greater awareness and more corporations will be addressing solid waste issues between 1993 and 1996. The research determined that corporate solid waste reduction efforts involve multiple members of the supply chain and indicates the members of the supply chain will be working closer together in the future. Chapter Five presents the conclusions drawn from these results.

CHAPTER V CONCLUSIONS

Introduction

This chapter will summarize how the research was conducted. It will develop conclusions from the information gathered from the mail surveys and the case studies. Suggestions will be made to improve the research methodology. Implications of the research conclusions will be offered. Opportunities for future research using this research as a base will be suggested.

Summary of Research

The research investigated how corporate solid waste management efforts affected purchasing operations, both internally and across the supply chain between 1990 and 1993 and projected changes between 1993 and 1996.

The research involved a two-stage methodology involving a questionnaire survey mailed to participants and case studies.

The survey was designed to provide multiple questions for testing each research hypothesis. The survey was pre-tested through faculty review and six personal industry interviews for content validity, ease of understanding, and the ability of the executives to answer the questions. The survey participants were a subset of purchasing executives from the membership list of the National Association of Purchasing Management. The target survey group for the research involved industries that are high tonnage users of packaging material, namely the chemical, electronics, and food and beverage industries. A pre-calling campaign was conducted to obtain the executive's commitment to complete the survey netting an overall response rate of 52.7%.

The survey data was compiled and analyzed using t-tests and chi-squared tests. The data analysis compared means for companies with a solid waste management effort against the means of companies without a solid waste management effort. The analysis also compared survey means identifying what had occurred between 1990 and 1993 against projected changes between 1993 and 1996.

The second stage of this research involved case study investigations to examine approaches in implementing and maintaining the following solid waste management efforts:

1. Respondent company works with supplier to reduce incoming primary, secondary and tertiary packaging material.
2. Respondent company reduces primary, secondary, and tertiary packaging material used internally through alternative packaging, reusable containers, and challenging the need for packaging.
3. Respondent company reduces the amount of outgoing primary, secondary, and tertiary packaging material used to meet the request of customers.

Participants of the case studies were identified by the surveys from the first stage and screened with preliminary interviews to ensure the case study would offer insights to a unique set of issues or implementation environments. Seven case studies were conducted. Each case study was summarized and compiled with the other case studies to identify commonalities and differences.

Research Conclusions

Common conclusions from the surveys and the case studies were combined together to derive the following conclusions:

General

A significant number of respondents reported that they had an "on-going" solid waste effort. The food and beverage industry and the chemical industry had significantly more respondents reporting an "on-going" effort.

The food and beverage industry was more active in packaging solid waste management efforts between 1990 and 1993. The chemical and electronics industries are projecting they will be much more active in their packaging solid waste management efforts between 1993 and 1996.

Conclusion:

Packaging solid waste management efforts will continue to grow. On an industry basis, the electronics and chemical industries lag behind the food and beverage industry but will have a higher level of effort between 1993 and 1996.

Motivation

Motivation to reduce packaging solid waste comes from many different areas. Primary reasons cited included cost avoidance, government regulation, and company culture. Factors promoting further emphasis in solid waste management efforts include increasing disposal costs, increasing solid waste legislation, improved infrastructure supporting alternative solutions to landfill disposal, and increasing demands from customers.

Conclusion:

Packaging solid waste management will become more important to companies between 1993 and 1996 as they become more aware of the issues, costs, and opportunities from internal and external sources.

Alternatives

There are a number of alternative solid waste management options available including reduction of packaging material, reusable containers, and recycling material for retromanufacturing. The overriding factor in considering the alternatives is total cost.

All case study companies had recycling efforts in place. Recycling is popular as an initial effort due to high visibility to employees, customers, and visitors, ease of implementation, and the availability of an infrastructure supporting company efforts.

All of the case study companies were trying to reduce the amount of material coming into the company.

Conclusion:

There are a number of alternatives available for solid waste management. The overriding factor in considering the alternatives is total cost. Companies are most likely to avoid bring material into the company.

Goals and Measurement

The case studies and written comments penciled into the margins of the survey indicated corporate solid waste management goals tend to be set with little hard analysis and are often based on a conservative "gut" feel.

Case study companies indicated measurement and tracking of reduction efforts are very difficult. They reported problems determining what to use as the base, what to measure, and how to effectively measure changes.

Inclusion of the solid waste management effort in a business case is subject to the availability of valid data and whether they are encouraged by the corporate culture.

Conclusion:

Solid waste management goals are typically set with little hard analysis. Accurate measurement of change is difficult. Inclusion of solid waste management efforts into company business cases is subject to valid and meaningful data.

Sharing Efforts with Suppliers

Companies with a formal, documented solid waste management effort were more likely to share their effort with suppliers. Companies who have integrated the solid waste management effort into procurement procedures are also more likely to share their effort with suppliers. Integration of a solid waste management effort into procurement procedures is not dependent on having a formal, documented effort.

Conclusion:

Companies that have a formal, documented solid waste management effort and have integrated the effort into their purchasing procedures are more likely to involve suppliers in the solid waste management effort.

Organizational Changes

A significant number of organizational changes were made to the procurement function between 1990 and 1993 to address solid waste management. There will continue to be changes to the purchasing organizational structure to support packaging solid waste management efforts between 1993 and 1996.

Organizational changes included modifying the job scope of a previous position or creating a special job assignment, making solid waste management a part of management responsibility, and modifying the mission of a department. The survey and the case studies both indicated that purchasing primarily plays a supportive role in solid waste management efforts. Organizational changes have been made in the context of assisting corporate efforts.

Fifty-nine percent of the companies reporting they did not have a solid waste management effort in 1993 indicated they expected to make purchasing organizational changes by 1996.

Conclusion:

Purchasing will continue to modify its organizational structure to play a supportive role in corporate solid waste management efforts.

Skill Requirements

Skills required by purchasing to support packaging solid waste management efforts changed between 1990 and 1993. Case study companies suggested these skills include an awareness of the issues, an

understanding of current and projected environmental legislation affecting the company, and awareness of current corporate efforts.

Conclusion:

Purchasing personnel supporting solid waste management efforts should receive training that provides awareness of solid waste issues and how they affect the corporate business activities.

Reusable Packaging

The chemical industry is more likely to pay a premium for reusable packaging. The food and beverage and the electronics industries are less likely to pay a premium for reusable packaging due to concerns about contaminated packaging.

Conclusion:

Concerns of packaging contamination will reduce the likelihood of a company reusing packaging material.

Influence on the "Buy" Decision

The purchasing "buy" decision has been influenced by packaging solid waste management efforts between 1990 and 1993. The amount of packaging material used by a supplier is part of the "buy" decision by companies with a solid waste management effort. It is not a major criterion in the supplier selection process but it has become more important between 1990 and 1993. Purchasing executives surveyed indicate it will increase in importance between 1993 and 1996 for most companies.

Supplier solid waste management efforts are more important to companies with their own solid waste management efforts.

Conclusion:

The importance of a supplier's solid waste management effort will continue to increase as part of the purchasing "buy" decision.

Differences in the Type of Packaging Material Used

Companies will be utilizing the same type of packaging commodity in 1996 as they did in 1990. There were no significant changes in the type of packaging materials used between 1990 and 1993 or projected between 1993 and 1996. Once a commodity is specified to be best for packaging the product, packaging improvements such as redesign and using reusable containers will continue to utilize the same commodity for the package.

Companies reporting they had a solid waste management effort increased the number of reusable containers used with customers and suppliers between 1990 and 1993. Purchasing executives surveyed projected they will continue to increase the number of reusable containers between 1993 and 1996.

Packaging redesign was a popular method used to reduce the amount of packaging material between 1990 and 1993. Case study companies indicated solid waste reductions resulting from packaging redesign are a secondary benefit to the overall cost reduction benefits derived from improving and reducing packaging design. Purchasing executives sur-

veyed projected a continued effort in packaging redesign between 1993 and 1996.

Conclusion:

Companies will be utilizing the same type of packaging commodities in 1996 as they did in 1990. Changes will emphasize reusable containers and packaging redesign for the benefit of overall cost reduction.

Differences in Packaging Characteristics

There was a consistent reduction of packaging weight and volume for primary, secondary, and tertiary packaging between 1990 and 1993. The reductions are projected to continue for both packaging weight and volume for primary, secondary, and tertiary packaging between 1993 and 1996. The greatest reduction will come from inbound primary packaging.

Between 1990 and 1993, companies with a packaging solid waste management effort had greater reductions of the weight of primary packaging material received from suppliers than those companies without a solid waste management effort. Purchasing executives surveyed projected this trend will continue between 1993 and 1996.

Conclusion:

Reduction of primary, secondary, and tertiary packaging weight and volume will continue between 1993 and 1996. The greatest improvement will come from inbound primary packaging.

Time to Make A Sourcing Decision

There was no difference in the time it took to make a sourcing decision which supported packaging solid waste efforts in 1990 and 1993.

Purchasing executives surveyed projected it would take longer to make a sourcing decision supporting packaging solid waste efforts between 1993 and 1996. The increase in the time to make a sourcing decision will affect companies regardless of whether they have a solid waste management effort.

Conclusion:

The time required to make a sourcing decision which supports packaging solid waste management efforts will increase between 1993 and 1996 and will affect all companies in the supply chain.

Complexity of Sourcing Decision

Sourcing decisions supporting packaging solid waste management efforts increased in complexity between 1990 and 1993. Solid waste management efforts have added another variable to be considered when making a sourcing decision.

Purchasing executives surveyed projected sourcing decisions supporting packaging solid waste management efforts will continue to increase in complexity between 1993 and 1996. There will be greater emphasis on solid waste management in the sourcing decision as it becomes further integrated throughout the supply chain.

Conclusion:

Solid waste management efforts have added another variable to be considered when making a sourcing decision. The integration of solid waste management throughout the supply chain will increase sourcing complexity.

Involving Contiguous Members of the Supply Chain

Few companies are willing to spend the time and effort to develop an infrastructure to support more solid waste management solutions. Companies are more likely to avoid bring material into the company by working with contiguous channel members. Joint efforts typically result in shared expertise and mutually acceptable improvements. A high percentage of the purchasing executives surveyed felt solid waste management is the role of both the customer and suppliers to actively reduce the solid waste stream.

Between 1990 and 1993 companies with an on-going solid waste management effort were more likely to work with suppliers to reduce the amount of inbound secondary and tertiary packaging. Purchasing executives from these companies projected they would continue the effort between 1993 and 1996, were more likely to agree that procurement plays a significant role in solid waste management efforts, that solid waste management is the role of both the customer and supplier, and were more likely to develop closer relationships with customers and suppliers to reduce solid waste in the channel.

A majority of all the purchasing executives surveyed indicated they expected efforts to reduce the amount of secondary and tertiary packaging with suppliers would increase between 1993 and 1996.

Most of the case study companies indicated they wished they had started their efforts earlier. One case study company commented that earlier heightened awareness would have helped guide some of the earlier decisions on staffing and supplier selection. Case study companies proclaiming themselves "behind" in their solid waste management efforts typically had efforts only involving their customers and had not expanded the effort to their own suppliers.

Conclusion:

Purchasing executives feel it is the role of both the customer and the supplier to reduce solid waste in the channel. The customer usually initiates the solid waste management effort. Companies with solid waste management efforts typically work with both their customers and suppliers to reduce solid waste.

Customer and Supplier Relationships

There has been an overall trend for companies to shift from a transactional business perspective to a relational business perspective between customers and suppliers. Efforts to manage solid waste between 1990 and 1993 has helped developed closer working relationships between customers and suppliers. Purchasing executives surveyed projected corporate solid waste management efforts will influence relationships between customers and suppliers more between 1993 and 1996 than they did between 1990 and 1993.

Companies are more likely to share their solid waste management efforts with suppliers if the effort has been integrated into purchasing procedures or if the solid waste management effort is formal and documented. Solid waste reduction efforts must extend throughout the supply chain to be effective. Sharing corporate solid waste reduction efforts with suppliers and customers offers a synergistic result and reduces sub-optimization.

Conclusion:

Corporate solid waste management efforts have influenced relationships between customers and suppliers between 1990 and 1993 and are projected to have a greater influence on relationships between 1993 and 1996

Other Conclusions from the Case Studies

The case studies provided the following additional information:

1. Most of the case study companies indicated increased legislation will help industry continue their solid waste management efforts and encourage them to do even more. Most projected government legislation will increase in the future.
2. Few case study companies indicated they felt it was their responsibility to develop end markets but all companies agreed that an increase in the number of end markets would help their solid waste management efforts.

Table 37

Summary of Acceptance/Rejection of Hypotheses H_{1.1} through H_{1.5}

		Hypothesis
Reject	1.1	There are no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1990 and 1993.
Reject	1.2	There are no differences in the skills required by purchasing to support packaging solid waste management efforts in 1990 and 1993.
Reject	1.3	There are no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1990 and 1993.
Accept	1.4	There are no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.
Reject	1.5	There are no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1990 and 1993.

Table 38

Summary of Acceptance/Rejection of Hypotheses H_{2.1} through H_{2.4}

		Hypothesis
Reject	2.1	There will be no differences in the purchasing organizational structure to support packaging solid waste management efforts in 1993 and 1996.
Reject	2.2	There will be no differences in the influence of packaging solid waste management efforts on the "buy" decision in 1993 and 1996.
Reject	2.3	There will be no differences in the time it takes to make a sourcing decision which supports packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.
Reject	2.4	There will be no differences in the complexity of a sourcing decision supporting packaging solid waste management efforts and a sourcing decision which does not support packaging solid waste management efforts in 1993 and 1996.

Table 39

Summary of Acceptance/Rejection of Hypotheses H3.1 through H3.6

		Hypothesis
Reject	3.1	There are no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.2	There are no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.3	There are no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Reject	3.4	There are no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1990 and 1993.
Accept	3.5	There are no differences in the type of packaging material used in 1990 and 1993.
Reject	3.6	There are no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1990 and 1993.

Table 40

Summary of Acceptance/Rejection of Hypotheses H_{4.1} through H_{4.6}

		Hypothesis
Reject	4.1	There will be no differences in the weight of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.2	There will be no differences in the volume of inbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.3	There will be no differences in the weight of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Reject	4.4	There will be no differences in the volume of outbound primary, secondary, and tertiary packaging used in 1993 and 1996.
Accept	4.5	There will be no differences in the type of packaging material used in 1993 and 1996.
Reject	4.6	There will be no differences in the purchasing relationships between customers and suppliers due to packaging solid waste management efforts in 1993 and 1996.

3. Suppliers are a part of the problem and also part of the solution.
4. Life cycle costing is generally not used by companies due to its high cost.

Research Methodology Conclusions

One of the advantages of completing a dissertation is that it helps to develop research skills. The dissertation is usually the largest individual research project attempted by the new researcher and should be used as a hand's on training experience to help learn what will and will not work in research. This section identifies some of the hand's on lessons learned from conducting this research.

Pre-Calling Effectiveness

Contacting potential survey respondents to gain a verbal commitment to complete a written survey before the survey was mailed achieved a 52.7% response rate. The decision to make the extra effort was made to reduce the risk of a low response rate. The time and effort spent on a doctoral dissertation is such that one wants to reduce as much risk as possible, even at additional time and expense. The lesson learned is that one must consider the tradeoff between an increased response rate and additional time and expense in the research methodology.

Timing When to Conduct the Research

Approval of the dissertation proposal was received at the beginning of summer. Preliminary calling and survey mailing started in June. One very important lesson learned was the timing of the survey instrument. Many of the preliminary telephone calls uncovered conflicts between the planned mailing date of the survey and planned vacation of the executive asked to fill out the survey. Every effort was made to mail the survey to coincide with availability of the executive. A survey mailing campaign conducted during Autumn, Winter, or Spring may have improved the response rate.

Mail Room Turnaround

The turnaround time of the campus mail room was longer than expected. This lesson suggests the importance of understanding the overall process of activities that can affect the research process. Project management emphasized timing which were controllable internally by the researcher and should have included more consideration of external uncontrollable factors such as mail room turnaround or summer vacation schedules.

Use of Phonemail Technology

The use of phonemail resulted in an unexpected efficiency in the research process. It likely reduced the number of callbacks required during the preliminary calling stage. The lesson learned is that technology may play an important role in improving the efficiency of research. Used correctly, technology such as phonemail may allow the researcher to conduct such activities as preliminary calling at a lower expense using less time.

Case Study Fallout Rate

There were nineteen companies that offered to participate in case studies. The list was reduced based on industry grouping and geographical location. The researcher was concerned that more companies would be qualified for case study than research funding could support. A number of companies from the list were eliminated during the pre-screening stage due to the amount of involvement required of the case study or a consensus between the researcher and the company that the company was not actively doing anything in the area of solid waste management. Hindsight suggests the researcher was too quick in paring down the initial list and inflexible in how a case study can be conducted. The lesson learned is that one should not be too quick in reducing the number of potential case study companies.

The initial methodology was to conduct on-site case studies and was accomplished with five of the seven case study companies. The researcher chose to conduct a telephone case study with one company for which he had previously worked because he was very familiar with the operations of the company and felt that complete questioning could still be accomplished. The success of the telephone case study prompted the researcher to conduct another telephone case study that also resulted in a complete series of questioning. The lesson learned is that the researcher could have successfully conducted a greater number of telephone case studies.

Summary

The hand's on lessons learned in this research will hopefully serve to improve the researcher's techniques and methodologies when conduct research in the future. Each new piece of research will likely provide additional hand's on lessons.

Implications

The conclusions from the research provide a basis to project the future direction of solid waste management and how it will affect companies and its purchasing organizations.

Social pressures and corporate awareness of solid waste issues will increase between 1993 and 1996 forcing more companies to actively manage solid waste.

The data from the survey indicated companies are expecting the emphasis on solid waste management to increase between 1993 and 1996. Companies that are not presently active in addressing the solid waste issues will experience increasing pressure to participate from key customers and suppliers.

Companies should proactively identify and track government solid waste reduction legislation that may affect operations throughout the supply chain.

Solid waste legislation is a dynamic process. If solid waste legislation continues to increase as it has in the past, companies must proactively identify and track governmental legislation on a national, state, county, or local basis. Those companies operating internationally must also consider current and potential legislation in all the countries in which they operate. Solid waste management efforts span the supply chain so an effort must be made to understand how the legislation will affect the operations of the company, customers, and suppliers.

Increasing disposal costs will economically stimulate the development of reverse logistics channels.

The research in this study indicated that the overriding influence in solid waste management is cost. Waste disposal costs are expected to continue to increase as they have in the past. Companies will seek alternative disposal methods to further reduce their solid waste output. Previously uneconomical alternatives may become economically justified. The reverse logistics infrastructure will evolve through increased demand and economic justification.

Increased participation in recycling will flood the reuse commodity markets with additional materials and commodity prices will continue to drop.

Waste disposal costs are projected to increase. Companies will initially implement traditional recycling programs to reduce their waste stream. Company recycling programs are highly visible and easy to set up within the operational structure of the company. Recycling results in

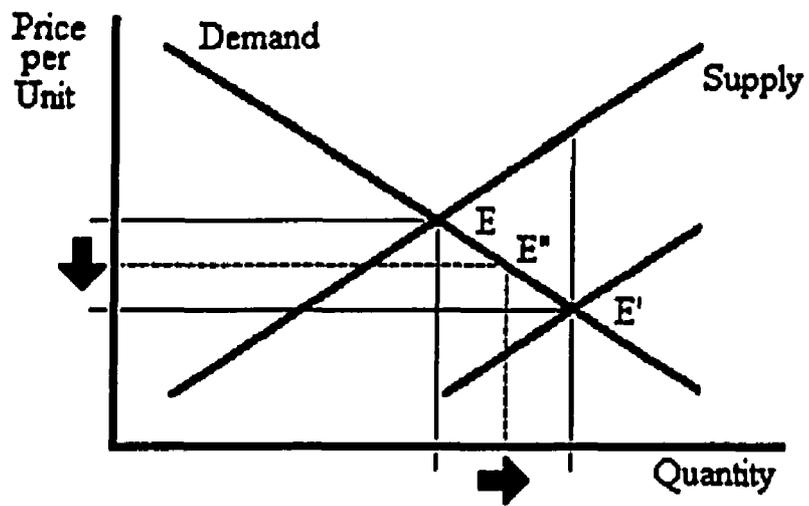


Figure 12

Increased Supply and Static Demand Reduces Commodity Prices

reduced disposal costs because the sale of the collected material covers part of the return logistics costs.

The effect of increased recycling will be to increase the supply of recyclable material entering an already overburdened reuse market that has a relatively fixed demand. The result will be a right hand shift of the equilibrium point on the supply and demand curve as shown in Figure Twelve that will result in dropping commodity prices.

There will be an increase in the growth of third parties supporting packaging solid waste management efforts.

Solid waste management is expected to receive more corporate emphasis between 1993 and 1996. Disposal costs are expected to increase and commodity prices are expected to decrease. There will be fewer easy alternatives to solid waste management and the increased awareness will raise expectations beyond implementation of a recycling plan. Companies will look to the outside for help in solid waste management. The number of third party facilitators will increase to provide expertise in areas such as packaging redesign and optimization and offer specialized solid waste logistical services. The third parties will survive as long as they can offer solid waste management expertise and services at a lower cost than companies would pay in-house.

The long term life of a company's solid waste management effort is dependent on valid measurement.

Solid waste management goals tend to be unscientific and measurements of change imprecise. Lack of precision may be overlooked in a scenario when the topic is timely and a company is rushing to satisfy the issues. Over the long run, the affect of the solid waste management effort must be measurable in financial terms. A measurement system should be developed which effectively measures change, identifies leverage points, and quantifies the changes in financial terms to substantiate that the effort supports corporate financial objectives.

Life cycle costing will not be utilized for packaging material until the cost to conduct a study decreases or the ramifications for not conducting a study increases.

Case study companies that have considered conducting a life cycle cost study on packaging material did not do so due to the high cost and low pay back. A life cycle costing study identifies the total cost of the an item through the item's entire life. The nature of packaging material is such that possession and visibility changes hands many times in its lifetime that complicates and increases the cost of a life cycle costing study. A company will not conduct a life cycle costing study of packaging material unless the cost to conduct a study can be reduced. Companies would conduct a life cycle costing study of packaging material if they are required to by law and penalties were assessed for not conducting the study.

Solid waste management efforts must be effectively communicated to employees, suppliers, and customers.

The trends projected by purchasing executives indicated companies would continue to expand their solid waste management efforts with contiguous members of the supply chain. Formal documentation of the solid waste management effort and integration into purchasing procedures was also important in supporting the expansion. Successful management of the supply chain will require clear understanding of goals and objectives by all participants

Suppliers of packaging material should focus on improving how their commodity can be more efficiently and effectively used.

Purchasing executives projected there would not be a great deal of change between packaging commodities between 1993 and 1996. Once a packaging commodity has been specified to be best for packaging a product, companies tend to maintain using the packaging commodity. Improvements to packaging materials between 1993 and 1996 have been projected to emphasize increased use of reusable containers and optimizing the design of the packaging. Suppliers of packaging material should emphasize assisting customers in accomplishing these changes with their packaging material.

As the awareness of solid waste issues increases, more suppliers and customers will involve contiguous members of the supply chain to reduce packaging solid waste. More companies will initiate solid waste management efforts.

Purchasing executives projected an expansion in the solid waste management efforts to include more suppliers and customers. Case study companies that indicated they were behind in their efforts to implement a solid waste management effort typically had efforts only involving their customers suggesting the companies became involved in solid waste management to satisfy their customers. The expansion of solid waste management efforts throughout the supply chain will result in more companies initiating a solid waste management effort to satisfy their customers.

How a company manages its solid waste will become another variable in the membership criteria to be a part of a customer's shrinking supplier base.

The expansion of solid waste management efforts throughout the supply chain will increase the importance of how well a company manages its own solid waste. A successful solid waste management effort will require the purchasing organization to maintain a base of suppliers who can successfully manage their own solid waste and minimize the amount of material they send to their customers.

Many customers are reducing their supplier base. Successful solid waste management may become perceived as a competitive advantage for a company to be considered for retention or addition to a customer's supplier base.

Characteristics of a Best Practice Company

The following describes the characteristics of a best practice company. It is a combination of corporate solid waste reduction efforts involving the purchasing function. It should be used as a normative guide for developing a corporate solid waste reduction effort which draws on the supply chain management abilities of the purchasing function.

- 1. On-going program which is always improving - Best practice corporate solid waste reduction efforts are the result of a committed, dynamic, on-going effort which continually seeks additional opportunities for improvement. The reduction effort is a part of the company culture and is included in the performance plans of purchasing personnel.**
- 2. All business decisions consider solid waste reduction issues - Corporate business cases identify the affect a decision may have on corporate solid waste reduction efforts. Decisions are made which consider the complete life cycle of a product or program and how it will impact the solid waste reduction effort.**
- 3. Goals are well defined and measured - Best practice companies have clearly defined their goals and identified how they will implement their solid waste reduction effort. These goals have been integrated into purchasing procedures. Each goal has at least one key measurement and the results are tracked over time.**

4. **Addresses all 4 R's - A complete corporate solid waste reduction effort will seek improvement through many different approaches. Recycling is a low cost, high visibility program but is only part of the solution. Best practice also seeks to incorporate source reduction, process and product redesign, reusability, and the procurement of recycled materials.**
5. **Help to develop the infrastructure - Many solid waste reduction efforts require a strong infrastructure to maintain an on-going effort. The lack of a strong infrastructure, such as a return channel, limits many potential corporate solid waste reduction efforts. Best practice seeks to assist in developing the infrastructure. Support may include working on the initial design of the return channel, offering financial support or investment, utilizing the return channel and acting as a conduit to initialize channel start-up and use by customers and suppliers.**
6. **Active in industry group - Many industries are working together to jointly address the lack of the infrastructure and help guide legislative efforts. Best practice companies are actively involved in these groups, choosing to address and shape the issues before solutions become mandated.**
7. **Integrated with contiguous suppliers and customers - Corporate solid waste reduction efforts are more effective if they are integrated into the supply chain. Efforts typically begin with actively working with key customers. The best practice companies utilize the abilities of**

their purchasing function to extend their effort to suppliers as well as customers.

8. **Education - Best practice companies educate their purchasing personnel about solid waste related issues. The education addresses how current solid waste issues affect the company, identify corporate goals and programs to reduce solid waste, and update current legal changes. The education extends throughout the company and also includes key customers and suppliers.**
9. **Included in the quotation process - The purchasing function includes corporate solid waste reduction efforts in request for quotations sent to potential suppliers. Supplier bids must address how their bid supports the corporate solid waste reduction effort.**
10. **Included in feedback to suppliers - Periodic supplier feedback includes an awareness of how the supplier is supporting the corporate solid waste reduction effort. The review helps to identify potential improvements which may be implemented by the supplier to help support the corporate effort.**

Future Research

This dissertation has attempted to answer four research questions in order to contribute to knowledge in the field of logistics. In doing so, the research has also attempted to identify other relevant questions concerning

solid waste management. The scope of the research was intentionally limited to packaging material and the food and beverage, electronics, and chemical industries in order to make the task manageable within the context of a doctoral dissertation. Future research may consider probing more closely into specific areas uncovered during the dissertation research or expanding the scope of the research into broader areas.

Expanding the Scope

The scope of the research could be extended beyond the limitations of this study. The research could address the all waste management efforts, the perspective of the chief executive officer, consider an international perspective, investigate the retail industry, develop a longitudinal study of corporate solid waste awareness and legal developments, investigate the complete supply chain, explore reduce, reuse, and recycle in greater detail.

Address All Waste Reduction Efforts

This study addressed only packaging and solid waste management. There are many other forms of waste reduction efforts which should be investigated including airborne and fluid waste. There are additional components of the solid waste stream which could also be investigated including the handling of hazardous waste, bio-degradable materials, and non-biodegradable materials. There may be parallels to the issues addressed in this study and there will be additional unique issues which should be addressed. This study may offer insights to some of the issues in these other areas.

CEO Perspective

This study addressed only the affect corporate solid waste reduction activities have on the purchasing function. Additional research could be conducted from a CEO perspective to address how solid waste reduction efforts affect other functional areas within a company. Strategic issues should be investigated to identify how far should a company go in reducing solid waste and how to determine the return on investment for a solid waste reduction program.

International Perspective

This study only studied domestic companies. Solid waste reduction efforts are not limited to only domestic companies. It may be argued that companies in other countries such as Germany are much further along than most U.S. companies when it comes to reducing solid waste. Additional research should address waste management on an international scale. It may also be argued that we are operating in a global economy and must also address solid waste considerations of the countries of our trading partners.

Investigate the Retail Industry

The dissertation research included purchasing executives from the food and beverage, chemical, and electronics industries. These industries were chosen because they use the greatest annual tonnage of packaging material. These industries do not always include the end consumer of the product as their contiguous customer. Further research should address the retail industry to extend the scope of the research to the end consumer portion of the supply chain. The research could address many of the same

types of questions of the dissertation study but would have a different emphasis of a retail customer instead of an industrial customer. Retailers may be able to provide an important additional link in the supply chain bridging to the end consumer.

Longitudinal Study of Corporate Solid Waste Awareness

A longitudinal study may be conducted which tracks the development of corporate solid waste awareness over time which would include how the awareness of solid waste issues developed and the motivational forces behind them starting as early as Carson's 1962 publication of *Silent Spring*. The end result would include a graphic timeline of public events and corporate actions correlating to changing awareness of solid waste issue. Understanding how corporations are motivated and develop awareness of solid waste issues may provide insights into how awareness will continue to develop in the future. It may also identify which variables have and have not been considered as industry has increased its awareness of solid waste issues.

Investigate a Complete Supply Chain

The methodology of the dissertation addressed three specific industries. An alternative approach is to analyze how a complete supply chain addresses solid waste management and would involve studying customers and suppliers of a principle company to understand how their relationships are affected by solid waste management efforts across the supply chain. The research should follow key packaging components from their origin at suppliers through the principle company to customers. The study would include all the members of the infrastructure who are involved with the

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269

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Recycling Recycling efforts by companies likely will provide the most empirical information for additional research. Recycling tends to be one of the first solid waste management activities a company undertakes. The logistical ramifications can be investigated to provide a perspective of what is being done and identifying key infrastructure to facilitate recycling of specific commodities.

Probing Closer

Lessons From the Food Industry

The survey findings indicated the food and beverage industry has been one of the forerunners in solid waste management. Additional case study research may be conducted to further understand what has worked and what has not worked in the food and beverage industry. Much of what can be learned in the food and beverage industry is transferable to other industries. Key areas to investigate include identifying improvements that offered the greatest gain, understanding how solid waste management was implemented, and determining how the efforts are measured and tracked.

Development of Effectiveness Scale

Companies that have implemented solid waste management efforts should have a basis on which to grade their effort relative to other solid waste management efforts. A grading scheme may be compiled which awards points for various activities including organizational changes,

involvement with customers and suppliers, reduction of the weight and volume of packaging materials, awareness education, period of time they have had a solid waste management effort, if their effort is shared with suppliers, formalized and documented, or integrated into their purchasing procedures, and development of measurement and tracking capabilities. Information from the survey used for this dissertation may be utilized as an initial base to identify which companies currently have a solid waste management effort. A preliminary grading system could be developed and sent to a preliminary subset of companies for completion. The results can be correlated with the survey responses to collaborate and confirm grading to provide a test as to whether the response is reasonable relative to other responses. After modification, the grading system should be sent to another subset of companies for confirmation. The final result will be a field tested grading system that provides an indication of how the company is doing relative to other companies.

Identify Proper Measurements

A shortcoming uncovered during the case study portion of the dissertation suggested companies are having a difficult time determining what should be measured and how best to measure it. Many solid waste management goals are set in a non-scientific manner with uncertain or imprecise measurement variables.

A research contribution would be to determine how companies are setting solid waste management goals and how they are measuring the changes. The research would seek to answer questions such as:

1. Should the solid waste management effort be based on volume or weight reduction?
2. At what point do you put a stake in the ground to begin your measurement process?
3. Can and should the measurement base be retroactive to an earlier date?
4. How much of the supply chain should be included in the measurements?
5. Is a computerized measuring system more effective and worth the additional cost?
6. At what point does it become economically justified to seek alternative methods of solid waste disposal?

The companies that indicated they had a solid waste management effort could be surveyed to probe how they address the above questions.

Summary

There are many opportunities for future research in the area of solid waste management. The research conducted for this dissertation can provide a good basis for many of the proposed projects by identifying which companies are currently addressing solid waste management.

Summary

This research addressed the affect of corporate solid waste management on the purchasing function from an internal and external perspective. This research offers insight into industrial practice and theory in five areas:

1. Solid Waste Effort Design

The research identifies how solid waste management policy have influenced purchasing operations, how corporate efforts to reduce solid waste have changed over the last three years, and how they will change over the next three years. Understanding how corporate solid waste reduce efforts affect the purchasing function will aid in designing an on-going corporate solid waste reduction plan.

2. Understanding Changes to the "Buy" Decision

This research examined how corporate solid waste management has influenced the "buy" decision by determining how decision factors have been modified over time and how they will influence the "buy" decision in the future. The research suggests leverage points within the purchasing "buy" decision where solid waste reduction with suppliers can best be implemented. Understanding how the "buy" decision will change will also serve as a guide for training purchasing personnel.

3. Changing Roles and Responsibilities of Purchasing

This research examined the effects corporate solid waste management efforts have had on functional relationships of purchasing within the firm. It offers insights into the changing roles and responsibilities of the purchasing function, skill requirements and resource requirements over the last three years and projected for the next three years. The research may be used to help guide the direction of the purchasing function in the future.

4. Changing Relationships Between Customers and Suppliers

This research examines if corporate solid waste management efforts between customers and suppliers have altered relationships by changing the requirements or expectations of the channel members over the last three years and projected changes over the next three years. The findings may be used to design a corporate solid waste reduction plan which effectively utilizes the ability of purchasing to manage the supply chain and involve key suppliers.

5. Lessons Learned From the Successful Industrial Practice

This research examines "successful practices" from industry. It examined what went right and what the companies would do differently in solid waste management efforts. The knowledge gathered was used to develop a prescriptive model of what the purchasing function of a best practice company does to support corporate solid waste reduction effort. Identification of how a best practice company reduces solid waste can be used as a guide for

companies which would like to begin or advance their solid waste reduction effort.

A summary of the answers to the research questions as determined through the surveys and case studies are found below:

Research Question 1

Corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation within the company:

- 1. By modifying the organizational structure of purchasing**
- 2. By requiring additional or unique procurement skills**
- 3. By influencing the "buy" decision**
- 4. By increasing the complexity of sourcing decisions**

Research Question 2

Corporate purchasing practices with respect to packaging materials will change within the next three years to respond to efforts to reduce solid waste generation within the company:

- 1. By continuing to modify the organizational structure for purchasing**
- 2. By continuing to influence the "buy" decision**
- 3. By increasing the time it takes to make a sourcing decisions**
- 4. By increasing the complexity of sourcing decisions**

Research Question 3

Corporate purchasing practices with respect to packaging materials changed in response to efforts to reduce solid waste generation throughout the supply chain:

- 1. By reducing the volume and weight of packaging material utilized between parties.**
- 2. By helping to develop closer working relationships between customers and suppliers.**

Research Question 4

Corporate purchasing practices with respect to packaging materials will change in response to efforts to reduce solid waste generation throughout the supply chain:

- 1. By continuing to reduce weight and volume of packaging material utilized between parties.**
- 2. By further helping to develop closer working relationships between customers and suppliers.**

APPENDIX A
GLOSSARY OF TERMS

Within the context of the research, the following definitions will be utilized:

Corporate Environmental Policy - that portion of corporate strategic policy which outlines how environmental issues are considered in the operational and tactical activities of the corporation.

Green Marketing - the practice of incorporating environmental topics such as recyclability, product labeling, biodegradable packaging, reusable containers, non-polluting products, and other "environmentally friendly" issues, into the marketing efforts such as packaging, advertising, and new product development of the firm. (Reverse Logistics, Council of Logistics Management, 1992, p. A2)

Lightweighting - Reducing the weight of packaging material, often through the use of composite materials or improved technology, by making the packaging medium thinner. "The average 16-ounce non-refillable bottle weight just over 9 ounces in 1984; by 1987 the weight had been shaved to just over 7 ounces, and the downward trend is continuing." (E. Joseph Stilwell, R. Claire Canty, Peter W. Kopf, and Anthony M. Montrone, Packaging for the Environment: A Partnership for Progress, New York, AMACOM, 1991, p. 59)

Operational Planning - The day-to-day planning to achieve more immediate goals. (Strategic Planning for Logistics, Council of Logistics Management, 1992. p. A1)

Packaging - "The tool that protects and contains goods so that the environmental impact of our consumption is minimized." (E. Joseph Stilwell, R. Claire Canty, Peter W. Kopf, and Anthony M. Montrone, Packaging for the Environment: A Partnership for Progress, New York, AMACOM, 1991, p. 6)

Primary Packaging - Packaging material which contains the final product such as beverage can or bottle.

Recyclable - Material that have useful physical or chemical properties after serving their original purpose and can be reused or remanufactured into additional products. (Office Recycling Handbook, Environmental Protection Agency, Region III, February 1991).

Recycled - A process through which materials that might otherwise be wasted are collected and processed for conversion (retromanufacturing) into new products that otherwise would have been made with virgin materials. Products do not have to contain 100% recycled materials to be called "recycled." (Plastics Packaging and the Environment - A Glossary of Terms. Council on Plastics and Packaging in the Environment, Washington, DC.)

Reduction - Changing the amount of packaging material required through redesign of the packaging container, use of alternative technologies, or alternate materials.

Reuse - Using materials in their original form following their initial processing such as the reuse of plastic scraps after molding operations. Sometimes called "recirculation."

Secondary Packaging - Packaging material used to consolidate product enclosed in primary packaging units to facilitate transportability such as beverage six pack plastic rings or cardboard container.

Strategic Planning - The process of identifying the long-term goals of the entity (where we want to be) and the broad steps necessary to achieve these goals over a long-term horizon (how to get there), incorporating the concerns and future expectations of the major stakeholders. (Strategic Planning for Logistics, Council of Logistics Management, 1992. p. A2)

Supply Chain - The flow of goods throughout the distribution channel from supplier to the ultimate consumer.

Tactical Planning - The intermediate planning greater than one year, often a three-year horizon. The tactical plans have specific action items to achieve more intermediate goals, which lead to the strategic objectives. (Strategic Planning for Logistics, Council of Logistics Management, 1992. p. A2)

Tertiary Packaging - Packaging material used to consolidate secondary packaging units to facilitate transportability such as beverage case or pallet. This includes the shipping container and all additional internal dunnage materials if any. (Environmentally Responsible Packaging Handbook, Draft Report, Herndon, VA: Institute of Packaging Professionals, October 16, 1991.)

Waste Reduction - Reducing the amount or type of waste generated, sometimes used synonymously with source reduction. (Decision-Makers Guide to Solid Waste Management, EPA/530-SW-89-072. Environmental Protection Agency, November 1989.)

Waste Stream - The flow of materials which will result in disposal within the short term.

APPENDIX B
SURVEY DOCUMENTATION



Academic Faculty of Marketing

1775 College Road
Columbus, OH 43210-1399
Phone 614-292-8808

Dear Sir (or Madam):

I am writing to ask for your assistance in an important research project that is being undertaken here at The Ohio State University. The purpose of the study is to determine the impact of corporate solid waste reduction efforts on Purchasing operations, specifically in reducing the amount of packaging material entering the corporate waste stream. The study is sponsored by the National Association of Purchasing Management (NAPM) as a doctoral grant and the results will be published in the journals and the trade press.

Ted Farris, the doctoral student conducting this study, will be contacting you by telephone shortly to ask for your cooperation in this study. We are hopeful that you can take 10 minutes to fill out a short mail questionnaire that will not only assist Ted in his research, but will help identify "best practice" in the purchasing field.

To thank you for your participation, we will be happy to send you an executive summary of the survey results for your industry prior to the release of the findings. Your individual response will be held in the strictest confidence and no respondent or company will be identified.

We thank you in advance for your assistance.

Sincerely,

Bernard J. La Londe
Mason Professor of Transportation and Logistics

**National
Association of
Purchasing
Management**

284
2055 East Centennial Circle
Post Office Box 22160
Tempe, Arizona 85285-2160
USA

602/752-NAPM (752-6276)
Facsimile 602/752-7890

June 1993

The enclosed questionnaire is being used to collect data for the research project "Issues, Challenges, and Changes Faced by Purchasing Professionals During the Implementation of Packaging Solid Waste Reduction Efforts."

The research is being done by and at the Ohio State University; the National Association of Purchasing Management is providing financial support for this project through its Doctoral Grant program.

Meaningful research findings are dependent on obtaining your data. We urge you to complete and return the questionnaire.



R. Jerry Baker, C.P.M.
Executive Vice President

For the purpose of answering the following questions, consider primary packaging to be the packaging material containing the product (i.e. soda pop can), secondary packaging to be the packaging material to group or combine primary packaging to facilitate short range movement (i.e. six pack ring), and tertiary packaging to be the packaging material to facilitate long range movement (i.e. the case or pallet)

Please indicate your degree of agreement or disagreement with each statement.

(SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, and SD = Strongly Disagree)

- | | | |
|----|---|---------------------|
| 1. | In the <u>last</u> three years, there has been a significant change in how we consider solid waste issues in our procurement decisions. | SA - A - N - D - SD |
| 2. | In the <u>next</u> three years, I expect additional pressure to consider solid waste issues in our procurement decisions. | SA - A - N - D - SD |
| 3. | The amount of packaging material used by a supplier is considered when selecting a supplier. | SA - A - N - D - SD |
| 4. | The amount of packaging material used by a supplier is more important <u>now</u> in the supplier selection process than it was in 1990. | SA - A - N - D - SD |
| 5. | The amount of packaging material used by a supplier <u>will be</u> more important in 1996 in the supplier selection process than it is now. | SA - A - N - D - SD |
| 6. | Solid waste reduction requires special or unique procurement skills. | SA - A - N - D - SD |
| 7. | The procurement function plays a significant role in corporate solid waste reduction. | SA - A - N - D - SD |
| 8. | It is the role of <u>both</u> customer and supplier to actively reduce the solid waste stream. | SA - A - N - D - SD |

- 9. In the last three years, corporate solid waste reduction efforts have significantly influenced relationships between customers and suppliers. SA - A - N - D - SD
- 10. In the next three years, I expect corporate solid waste reduction efforts will significantly influence relationships between customers and suppliers. SA - A - N - D - SD
- 11. In the last three years, my company made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company. SA - A - N - D - SD
- 12. In the next three years, I expect my company to make a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company. SA - A - N - D - SD

Question 13
 Please indicate how much more your company would be willing to pay for packaging which could be reused compared to one-time use packaging.

Number of times packaging may be re-used		
Two Times (2X)	Five Times (5X)	Ten Times (10X)
%	%	%

Question 14

Please provide your best estimate of packaging reduction efforts by:

	Between 1990 & 1993		Between 1993 & 1996	
	By Weight	By Volume	By Weight	By Volume
Your Company				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%
Your Suppliers				
Primary Packaging	%	%	%	%
Secondary/Tertiary Packaging	%	%	%	%

Question 15

Please identify the solid waste reduction efforts (or anticipated efforts) undertaken by your company:

<u>With Suppliers</u>		<u>With Customer</u>		
<u>Between 90 & 93</u>	<u>Between 93 & 96</u>	<u>Between 90 & 93</u>	<u>Between 93 & 96</u>	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reducing the amount of packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Increasing the number of reusable containers
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Redesigning packaging
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Working to better understand packaging needs
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Use of outside consultants
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Other (please specify) _____

Question 16

Please estimate the type of packaging material utilized within your company:

<u>Packaging Commodity</u>	<u>1990</u>	<u>1993</u>	<u>1996</u>
Corrugated/Fiber Boxes	%	%	%
Paper Sacks	%	%	%
Plastic/Rubber containers	%	%	%
Plastic Shrink Wrap	%	%	%
Pallets	%	%	%
Metal	%	%	%
Composites	%	%	%
Other _____	%	%	%
TOTAL	100 %	100 %	100 %

Question 17

Please identify organizational changes (or anticipated changes) within the procurement function addressing solid waste reduction.

	<u>Now</u>	<u>By 1996</u>
Created a special department	<input type="radio"/>	<input type="radio"/>
Created a special job assignment	<input type="radio"/>	<input type="radio"/>
Modified the job scope of a previous position	<input type="radio"/>	<input type="radio"/>
Made solid waste reduction a part of management accountability	<input type="radio"/>	<input type="radio"/>
Modified mission of a previous department	<input type="radio"/>	<input type="radio"/>
No changes have taken place	<input type="radio"/>	<input type="radio"/>
Other (please specify) _____	<input type="radio"/>	<input type="radio"/>

Question 18

What is the job title of the procurement person primarily responsible for solid waste reduction efforts?

Question 19

How have efforts to reduce solid waste over the last three years modified your relationship?

- | With
Suppliers | With
Customers | |
|-----------------------|-----------------------|---|
| <input type="radio"/> | <input type="radio"/> | Helped us develop a closer working relationship |
| <input type="radio"/> | <input type="radio"/> | Kept us at an arm's length relationship |
| <input type="radio"/> | <input type="radio"/> | No change |
| <input type="radio"/> | <input type="radio"/> | Not sure |
| <input type="radio"/> | <input type="radio"/> | Other (please specify) _____ |

Question 20

Over the last three years, our solid waste reduction efforts have:

- increased sourcing lead time
- not changed the sourcing lead time
- reduced the sourcing lead time

Over the next three years do you expect this trend to continue?

- Yes No If No, why not? _____

Question 21

Over the last three years, our solid waste reduction efforts have:

- increased the complexity of sourcing
- not changed the complexity of sourcing
- reduced the complexity of sourcing

Over the next three years do you expect this trend to continue?

- Yes No If No, why not? _____

Question 22

What is your position or title?

How long have you held this position?

Question 23

Does your company have a on-going solid waste reduction effort?

- Yes No

If the answer to the above question is YES, is your solid waste reduction effort:

- | Yes | No | |
|-----------------------|-----------------------|---|
| <input type="radio"/> | <input type="radio"/> | A formal, documented effort? |
| <input type="radio"/> | <input type="radio"/> | Shared with your suppliers? |
| <input type="radio"/> | <input type="radio"/> | Integrated within your procurement procedure? |

Question 24

How are each of the following primarily managed? (Please check one level only)

- | Procurement | Solid waste | |
|-----------------------|-----------------------|-----------------------------|
| <input type="radio"/> | <input type="radio"/> | On a corporate level |
| <input type="radio"/> | <input type="radio"/> | On a local/divisional level |
| <input type="radio"/> | <input type="radio"/> | Both |

Please include any company information such as solid waste studies, internal newsletters, corporate announcements, organization charts relating to your corporate solid waste reduction effort.

Thank you for your participation. If you would be interested in receiving a executive summary of survey results, please include your business card with your completed questionnaire.

Please mail this completed questionnaire in the enclosed envelop to:

M. T. Farris II
1775 College Road
The Ohio State University
Columbus, OH 43210
Office: (614) 292-2959
Fax: (614) 292-0879

We are continuing to conduct research in this area and are planning to conduct field case studies where a university researcher visits a company and conducts personal interviews with various functional managers to further probe how solid waste reduction was implemented. A descriptive write-up will be completed which may potentially be published after review and approval. Would you be interested in talking to us further?

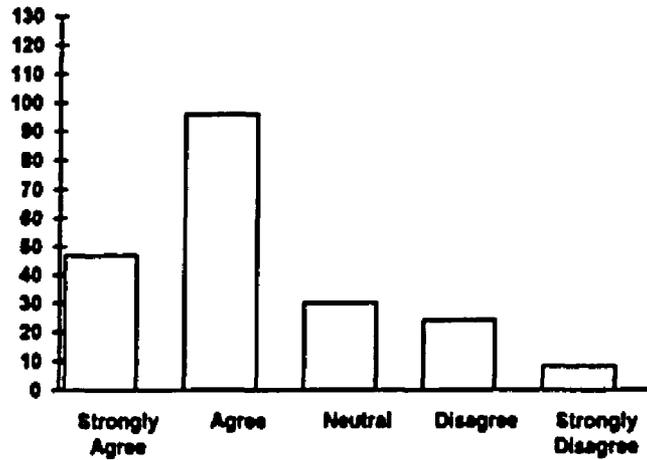
- Yes No

This number is used solely for tracking purposes. Confidentiality of your responses will be strictly maintained.

APPENDIX C
STATISTICAL ANALYSIS OF SURVEY RESPONSES

Question #1

In the last three years, there has been a significant change in how we consider solid waste issues in our procurement decisions.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	4.25	2.13	1.89	0.154
Residual Error	200	225.39	1.13		
Total	202	229.64			

Critical test value = 3.34

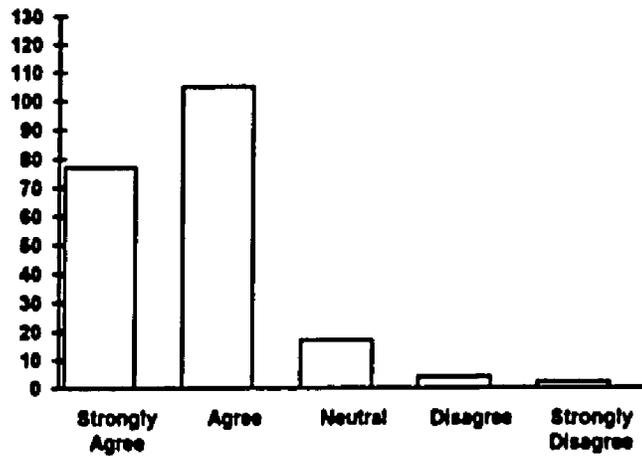
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.612	1.186	(0.353, 0.871)
Electronic	63	0.698	0.961	(0.452, 0.945)
Food	55	0.964	0.962	(0.699, 1.229)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	132	0.977	0.937	0.082
μ : Without Reduction Effort	72	0.260	1.130	0.130
		T		P-Value
		4.58		0.0000

Question #2

In the next three years, I expect additional pressure to consider solid waste issues in our procurement decisions.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.238	0.119	0.20	0.816
Residual Error	200	116.786	0.584		
Total	202	117.025			

Critical test value = 3.34

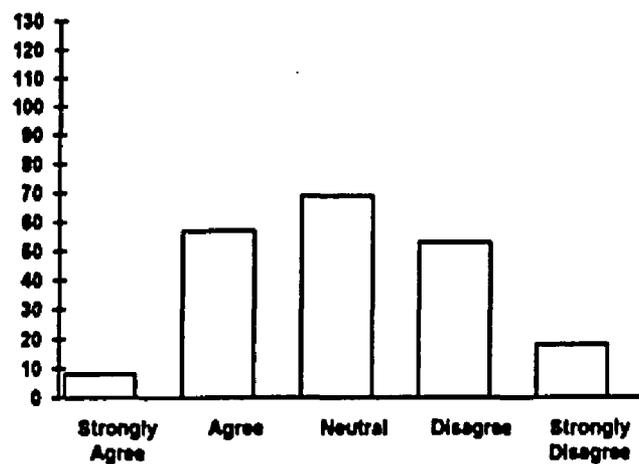
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	1.1882	0.7637	(1.0214, 1.3550)
Electronic	63	1.2222	0.6826	(1.0474, 1.3971)
Food	55	1.2727	0.8488	(1.0390, 1.5070)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	132	1.402	0.652	0.057
μ : Without Reduction Effort	72	0.903	0.842	0.099
		T		P-Value
		4.36		0.0000

Question #3

The amount of packaging material used by a supplier is considered when selecting a supplier.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	5.14	2.57	2.52	0.083
Residual Error	200	203.89	1.02		
Total	202	209.03			

Critical test value = 3.34

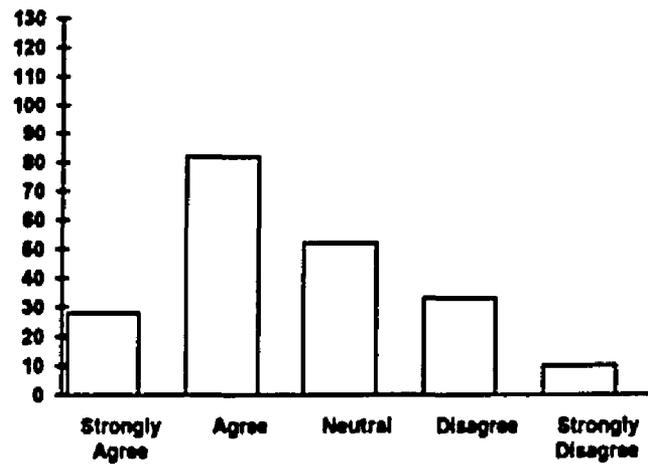
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	-0.118	1.074	(-0.352, 0.117)
Electronic	63	-0.222	0.991	(-0.476, 0.032)
Food	55	0.182	0.925	(-0.073, 0.437)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	132	0.159	0.948	0.082
μ : Without Reduction Effort	72	-0.542	0.978	0.12
		T		P-Value
		-4.94		0.0000

Question #4

The amount of packaging material used by a supplier is more important now in the supplier selection process than it was in 1990.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	2.48	1.24	1.09	0.337
Residual Error	200	226.93	1.13		
Total	202	229.41			

Critical test value = 3.34

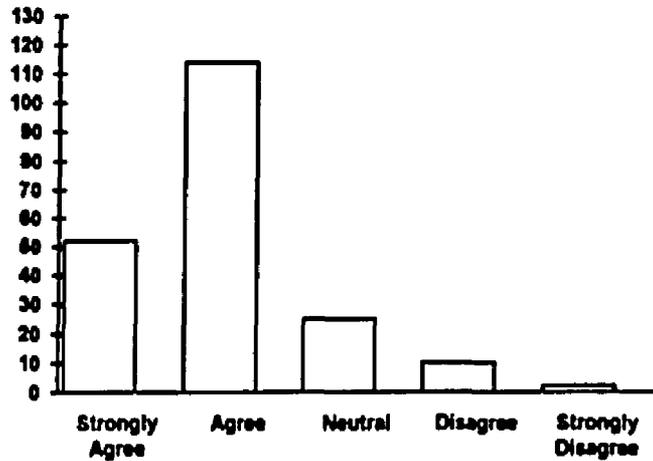
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.353	1.131	(0.106, 0.600)
Electronic	63	0.349	1.003	(0.092, 0.606)
Food	55	0.600	1.029	(0.316, 0.884)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	132	0.621	0.985	0.086
μ : Without Reduction Effort	72	0.010	1.090	0.130
		T		P-Value
		3.92		0.0001

Question #5

The amount of packaging material used by a supplier will be more important in 1996 in the supplier selection process than it is now.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	1.408	0.704	1.05	0.352
Residual Error	199	132.592	0.670		
Total	201	134.000			

Critical test value = 3.34

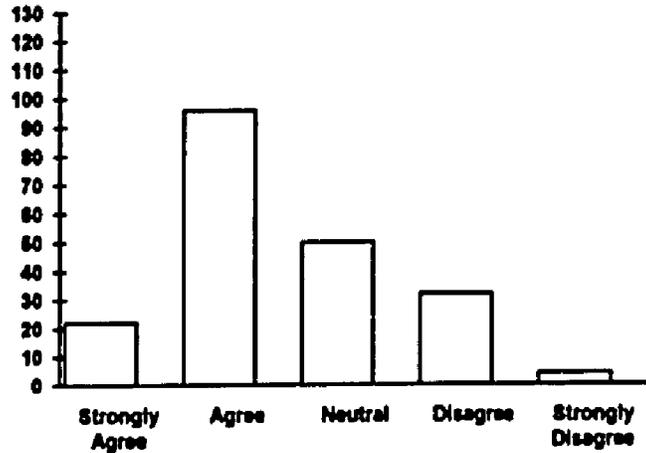
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.9059	0.9338	(0.7020, 1.1100)
Electronic	63	1.0968	0.6455	(0.9300, 1.2636)
Food	54	1.0370	0.8001	(0.8140, 1.2600)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	130	1.162	0.776	0.068
μ : Without Reduction Effort	72	0.722	0.826	0.097
		T		P-Value
		3.70		0.0003

Question #6

Solid waste reduction requires special or unique procurement skills.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.951	0.475	0.52	0.595
Residual Error	199	181.530	0.912		
Total	201	182.480			

Critical test value = 3.34

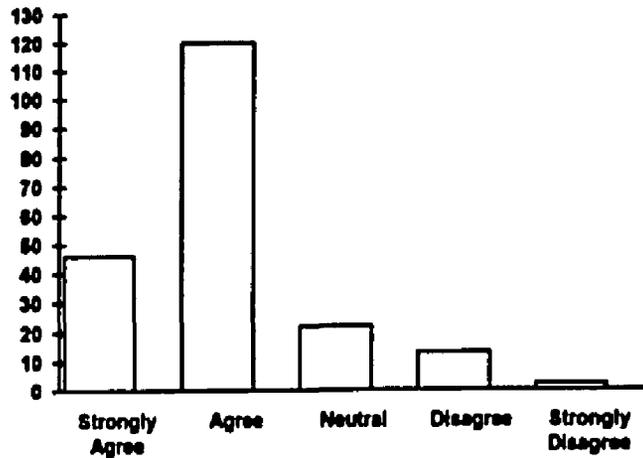
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.4353	0.9316	(0.232, 0.639)
Electronic	62	0.4677	1.0357	(0.200, 0.735)
Food	55	0.6000	0.8944	(0.353, 0.847)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	0.557	0.913	0.080
μ : Without Reduction Effort	72	0.360	1.010	0.120
		T		P-Value
		1.37		0.17

Question #7

The procurement function plays a significant role in corporate solid waste reduction.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	4.818	2.409	3.59	0.029
Residual Error	198	132.863	0.671		
Total	200	137.682			

Critical test value = 3.34

Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	84	0.8214	0.9589	(0.5550, 1.0750)
Electronic	62	0.9355	0.6496	(0.7676, 1.1033)
Food	55	1.2000	0.7552	(0.9920, 1.4080)

	Chemical	Electronic
Electronic	0.1141 0.39	
Food	0.3786 0.0430	0.2645 0.0938

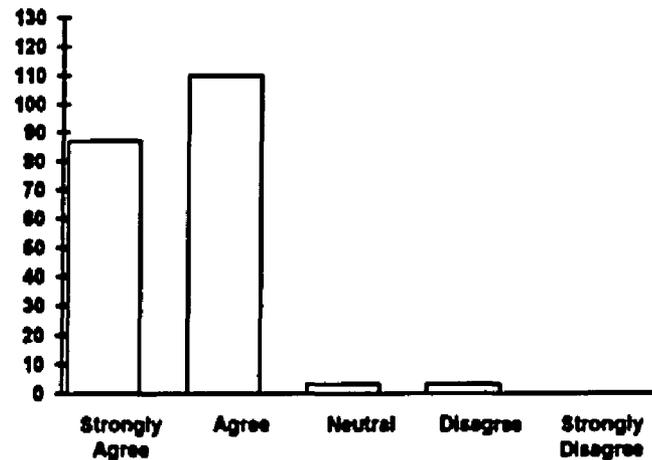
Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	1.038	0.845	0.074
μ : Without Reduction Effort	71	0.817	0.780	0.093

T	P-Value
1.87	0.064

Question #8

It is the role of both customer and supplier to actively reduce the solid waste stream.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.291	0.145	0.40	0.668
Residual Error	198	71.212	0.360		
Total	200	71.502			

Critical test value = 3.34

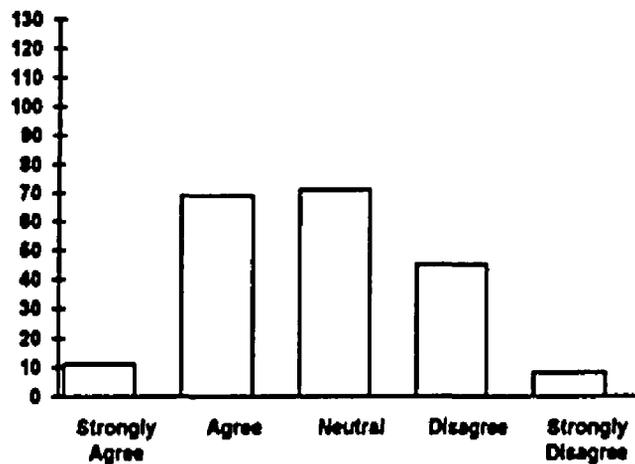
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	84	1.3452	0.6304	(1.2602, 1.5468)
Electronic	62	1.4355	0.6173	(1.2760, 1.5950)
Food	55	1.3818	0.5267	(1.2366, 1.5270)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	130	1.469	0.573	0.050
μ : Without Reduction Effort	72	1.222	0.610	0.072
		T		P-Value
		2.81		0.0056

Question #9

In the last three years, corporate solid waste reduction efforts have significantly influenced relationships between customers and suppliers.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	3.515	1.757	1.94	0.146
Residual Error	199	180.030	0.905		
Total	201	183.545			

Critical test value = 3.34

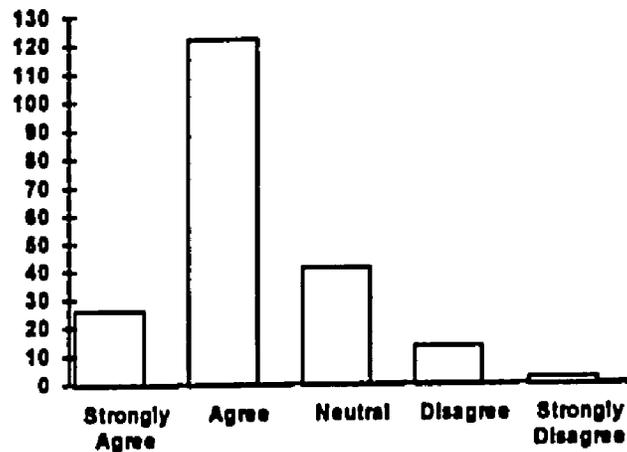
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.0588	0.9044	(-0.1387, 0.2563)
Electronic	62	0.0806	1.0449	(-0.1890, 0.3510)
Food	55	0.3636	0.9101	(0.1130, 0.6150)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	0.267	0.967	0.085
μ : Without Reduction Effort	72	-0.083	0.900	0.110
		T		P-Value
		2.58		0.011

Question #10

In the next three years, I expect corporate solid waste reduction efforts will significantly influence relationships between customers and suppliers.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.100	0.050	0.08	0.922
Residual Error	199	122.875	0.617		
Total	201	122.975			

Critical test value = 3.34

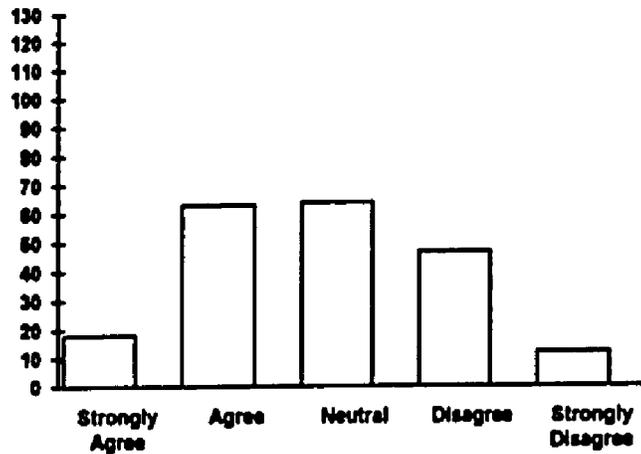
Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.8000	0.7838	(0.6288, 0.9712)
Electronic	62	0.7742	0.7979	(0.5680, 0.9800)
Food	55	0.7455	0.7750	(0.5320, 0.9590)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	0.939	0.677	0.059
μ : Without Reduction Effort	72	0.458	0.887	0.100
		T		P-Value
		4.00		0.0001

Question #11

In the last three years, my company made a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	17.50	8.75	8.56	0.000
Residual Error	199	203.34	1.02		
Total	201	220.84			

Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	-0.082	1.060	(-0.314, 0.149)
Electronic	62	0.032	0.958	(-0.215, 0.280)
Food	55	0.618	0.991	(0.345, 0.891)

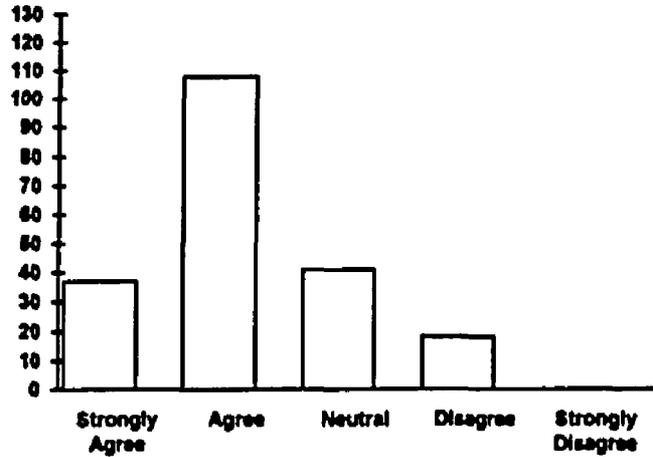
	Chemical	Electronic
Electronic	0.114 0.49	
Food	0.700 0.0001	0.586 0.0016

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	0.473	0.923	0.081
μ : Without Reduction Effort	72	-0.500	0.979	0.120
		T		P-Value
		6.92		0.0000

Question #12

In the next three years, I expect my company to make a significant effort to work with suppliers to reduce the amount of secondary and tertiary packaging sent to my company.



Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	1.159	0.580	0.84	0.434
Residual Error	199	137.692	0.692		
Total	201	138.851			

Critical test value = 3.34

Industry	Count	Mean	Standard Deviation	Confidence Intervals
Chemical	85	0.7412	0.8473	(0.5561, 0.9262)
Electronic	62	0.8065	0.7648	(0.6088, 1.0041)
Food	55	0.9273	0.8789	(0.6850, 1.1700)

Test for $\mu_{\text{effort}} = \mu_{\text{no effort}}$

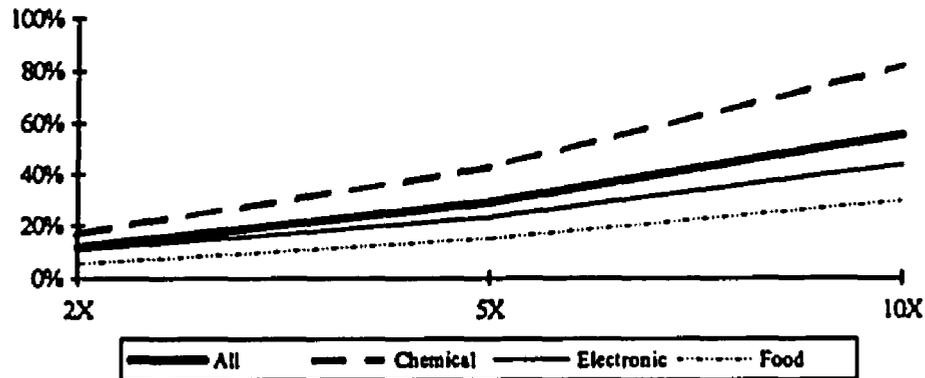
	N	Mean	Standard Deviation	Standard Error
μ : With Reduction Effort	131	1.084	0.680	0.059
μ : Without Reduction Effort	72	0.278	0.843	0.099
		T		P-Value
		6.97		0.0000

Question #13

Please indicate how much more your company would be willing to pay for packaging which could be reused compared to one-time use packaging.

		Number of times packaging may be re-used		
		Two Times (2X)	Five Times (5X)	Ten Times (10X)
Overall	n = 120	12.0%	29.0%	55.6%
Chemical	n = 49	17.1%	42.7%	82.0%
Electronic	n = 38	10.8%	23.3%	43.8%
Food	n = 33	5.8%	15.2%	29.7%

Premium for Reusable Packaging

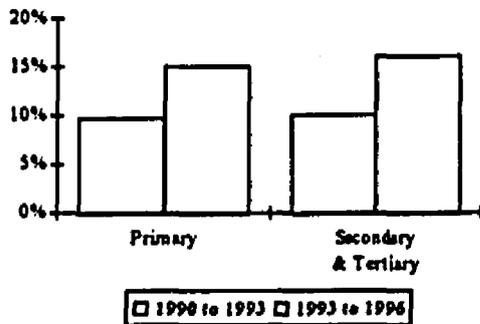


Question 14

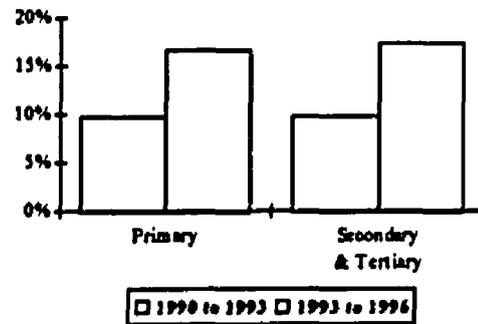
Please provide your best estimate of packaging reduction efforts by:

	Between 1990 & 1993		Between 1993 & 1996	
	By Weight	By Volume	By Weight	By Volume
Your Company				
Primary Packaging	9.7%	9.7%	15.0%	16.6%
Secondary/Tertiary Packaging	10.1%	9.8%	16.1%	17.3%
Your Suppliers				
Primary Packaging	7.8%	9.5%	13.0%	15.5%
Secondary/Tertiary Packaging	9.3%	9.1%	14.8%	17.3%

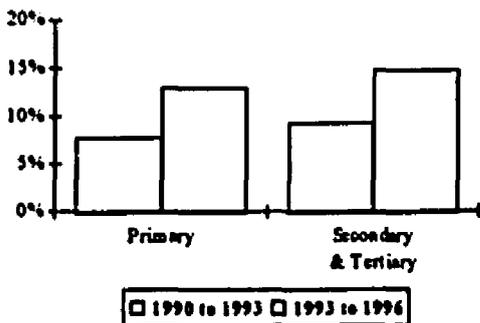
Company Packaging Reduction Efforts By Weight



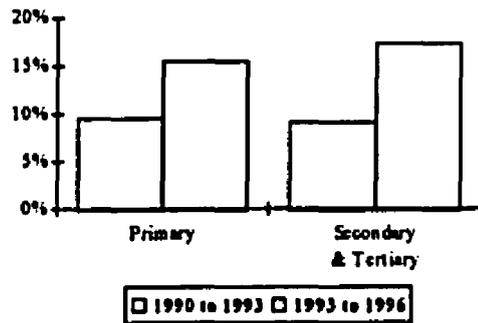
Company Packaging Reduction Efforts By Volume



Supplier Packaging Reduction Efforts By Weight



Supplier Packaging Reduction Efforts By Volume



**μ Last three years versus μ Next three years
p - values**

	<u>By Weight</u>	<u>By Volume</u>
Your Company		
Primary Packaging	0.0110	0.0016
Secondary/Tertiary Packaging	0.0039	0.0008
Your Suppliers		
Primary Packaging	0.0072	0.0140
Secondary/Tertiary Packaging	0.0082	0.0006

**μ Solid Waste Effort versus μ No Solid Waste Effort
p - values**

	<u>Between 1990 & 1993</u>		<u>Between 1993 & 1996</u>	
	<u>By Weight</u>	<u>By Volume</u>	<u>By Weight</u>	<u>By Volume</u>
Your Company				
Primary Packaging	0.35	0.13	0.39	0.45
Secondary/Tertiary Packaging	0.47	0.35	0.58	0.91
Your Suppliers				
Primary Packaging	0.034	0.25	0.085	0.51
Secondary/Tertiary Packaging	0.18	0.33	0.95	0.93

Question 15

Please identify the solid waste reduction efforts (or anticipated efforts) undertaken by your company:

With Suppliers		With Customer		(answers not exclusive) n = 159
Between 1990 & 1993	Between 1993 & 1996	Between 1990 & 1993	Between 1993 & 1996	
83	102	71	90	Reducing the amount of packaging
60	87	51	67	Increasing the number of reusable containers
81	109	69	91	Redesigning packaging
66	99	69	96	Working to better understand packaging needs
9	21	12	12	Use of outside consultants
6	9	6	10	Other (please specify)
X	X	X	X	Using recycled and recyclable containers/paperboard
X	X	X	X	Using recycled materials
X	X	X	X	Barcoding
X	X	X	X	In-house packaging engineer
X	X		X	Better choices for biodegradability
X	X			Lightweighting packaging & using recycled containers
	X	X	X	Buy recycled content packaging
	X		X	New Materials
	X		X	Move from drums to bulk or semi-bulk totes
			X	Vendor expertise
		X	X	Recycling program for paper products

μ 1990 and 1993 versus μ 1993 and 1996

With Suppliers		P - value	
Between 1990 & 1993	Between 1993 & 1996		
83	102	0.0310	Reducing the amount of packaging
60	87	0.0023	Increasing the number of reusable containers
81	109	0.0013	Redesigning packaging
66	99	0.0002	Working to better understand packaging needs
9	21	0.0210	Use of outside consultants
6	9	0.4300	Other (please specify)

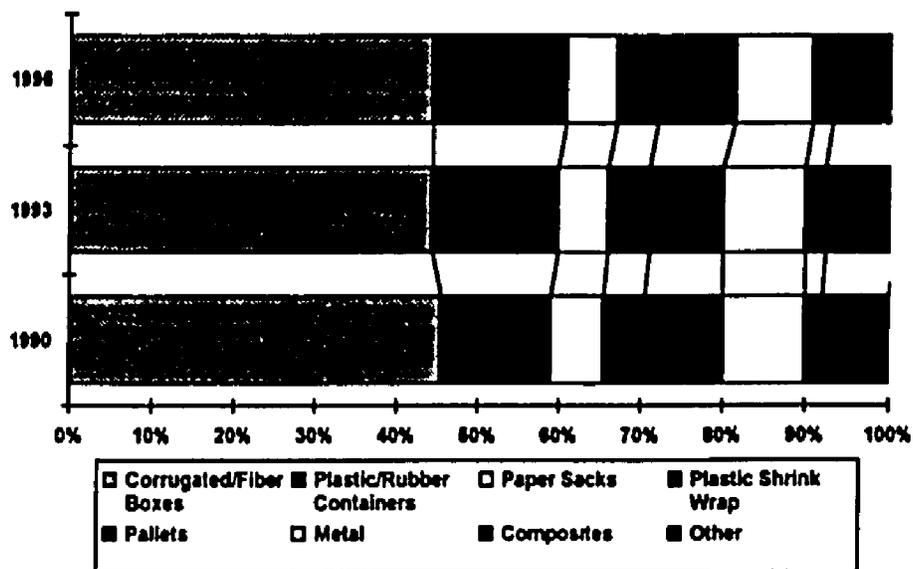
With Customers		P - value	
Between 1990 & 1993	Between 1993 & 1996		
67	87	0.0310	Reducing the amount of packaging
51	65	0.0620	Increasing the number of reusable containers
65	87	0.0120	Redesigning packaging
64	91	0.0020	Working to better understand packaging needs
12	12	1.0000	Use of outside consultants
6	10	0.3100	Other (please specify)

Question 16

Please estimate the type of packaging material utilized within your company:

n = 133

Packaging Commodity	1990	1993	1996
Corrugated/Fiber Boxes	46%	44%	44%
Paper Sacks	7%	6%	6%
Plastic/Rubber containers	14%	15%	16%
Plastic Shrink Wrap	5%	5%	5%
Pallets	10%	9%	9%
Metal	10%	10%	9%
Composites	2%	2%	2%
Other	8%	8%	8%
TOTAL	100 %	100 %	100 %



Plastic/Rubber Containers
 μ_{1990} versus μ_{1996}

1990	1996	P - value	
13.8%	16.4%	.38	Plastic/Rubber Containers

Question #17

Please identify organizational changes (or anticipated changes) within the procurement function addressing solid waste reduction.

(Answers are not mutually exclusive except for "No changes have taken place")

	Now	By 1996
Created a special department	7	13
Created a special job assignment	27	40
Modified the job scope of a previous position	59	61
Made solid waste reduction a part of management accountability	56	68
Modified mission of a previous department	29	29
No changes have taken place	70	34
Other (please specify)	5	3

Now	By 1996	
X	X	Task Force
X		Center of Excellence for Environmentally Improved Packaging
X		Recycling Committee
X		Have a review committee
X		Council on reusable/recyclable packaging leading to solid waste reduction
	X	Making reusable packaging a contract requirement
	X	Track amount

	N	Mean	Standard Deviation	Standard Error
Now	174	.5977	.4918	.0373
1996	156	.7821	.4142	.0332

(Any Change = 1, No Change = 0)

Test Comparing μ_{Now} versus μ_{1996}

T	P - Value
3.69	0.0003

Count Row Percent Column Percent Total Percent	Solid Waste Reduction Effort	No Solid Waste Reduction Effort	Row Total
Organizational Change Now	89 85.6% 74.2% 51.1%	15 14.4% 27.8% 8.6%	104 59.8%
No Organizational Change	31 44.3% 25.8% 17.8%	39 55.7% 72.2% 22.4%	70 40.2%
Column Total	120 69.0%	54 31.0%	174 100.0%

$$\chi^2 = 33.329 \quad 1 \text{ degree of freedom} \quad p = 0.0000$$

Count Row Percent Column Percent Total Percent	Formal Effort	No Formal Effort	Row Total
Organizational Change Now	49 59.0% 83.1% 44.1%	34 41.0% 65.4% 30.6%	83 74.8%
No Organizational Change	10 35.7% 16.9% 9.0%	18 64.3% 34.6% 16.2%	28 25.2%
Column Total	59 53.2%	52 46.8%	111 100.0%

$$\chi^2 = 4.573 \quad 1 \text{ degree of freedom} \quad p = 0.0345$$

Count Row Percent Column Percent Total Percent	Shared with Suppliers	Not Shared with Suppliers	Row Total
Organizational Change Now	63 75.0% 79.7% 56.3%	21 25.0% 63.6% 18.8%	84 75.0%
No Organizational Change	16 57.1% 20.3% 14.3%	12 42.9% 36.4% 10.7%	28 25.0%
Column Total	79 70.5%	33 29.5%	112 100.0%

$$\chi^2 = 3.222 \quad 1 \text{ degree of freedom} \quad p = 0.0773$$

Count Row Percent Column Percent Total Percent	Integrated in Purchasing Procedures	Not Integrated in Purchasing Procedures	Row Total
Organizational Change Now	57 68.7% 80.3% 50.9%	26 31.3% 63.4% 23.2%	83 74.1%
No Organizational Change	14 48.3% 19.7% 12.5%	15 51.7% 36.6% 13.4%	29 25.9%
Column Total	71 63.4%	41 36.6%	112 100.0%

$\chi^2 = 3.854$ 1 degree of freedom p = 0.0497

What Companies Without "an Effort" Are Doing

	Now n = 15	By 1996 n = 41
Created a special department	0	4
Created a special job assignment	3	11
Modified the job scope of a previous position	10	14
Made solid waste reduction a part of management accountability	5	19
Modified mission of a previous department	3	9
No changes have taken place	39	20
Other (please specify)	1	2

Bridging Responses Projecting 1996 with Responses for 1993

	Solid Waste Reduction Effort	No Solid Waste Reduction Effort
Solid Waste Policy	<u>89</u> 1993 Total	<u>39</u> 1993 Total
	*67 Effort reported for 1993; and in 1996	*19 No effort in 1993; nor in 1996
	16 No effort in 1993; effort in 1996	1 Effort in 1993; no effort in 1996
	2 No report in 1993; effort in 1996	-18 No effort in 1993; effort in 1996
	-1 Effort in 1993; no effort in 1996	<u>-2</u> <u>No 1993 report; no 1996 report</u>
	<u>-21</u> <u>Effort reported in 1993; no 1996 report</u>	20 1996 Total
	<u>85</u> 1996 Total	
No Solid Waste Policy	<u>15</u> 1993 Total	<u>31</u> 1993 Total
	18 No effort in 1993; effort in 1996	*13 No effort in 1993; nor in 1996
	*11 Effort reported for 1993; and in 1996	1 Effort in 1993; no effort in 1996
	8 No report in 1993; effort in 1996	-16 No effort in 1993; effort in 1996
	-3 Effort reported in 1993; no 1996 report	<u>-2</u> <u>No 1993 report; no 1996 report</u>
	<u>-1</u> <u>Effort in 1993; no effort in 1996</u>	14 1996 Total
	<u>37</u> 1996 Total	

* - Common to both time periods

Question #18

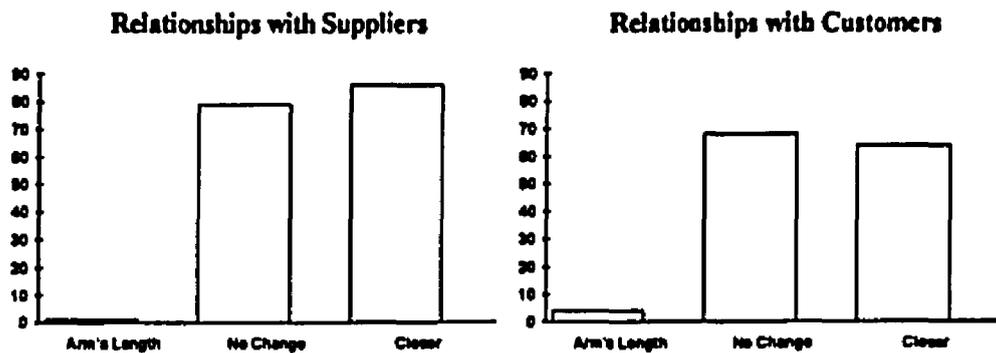
What is the job title of the procurement person primarily responsible for solid waste reduction efforts?

None Assigned or noted	63
Manager	37
Buyer/Senior Buyer/Purchasing Agent	35
Director	26
All employees	12
Vice President	9
Packaging and Environmental Services	4
General Manager	3
President/Owner	2
Task Force	2
Manufacturing/Production	2
Packaging Engineer	2
Management	2
Corporate Distribution	1
Office Supervisor	1
Building Supervisor	1
3rd Party	1

Question #19

How have efforts to reduce solid waste over the last three years modified your relationship?

With Suppliers n = 184	With Customers n = 172	
86	64	Helped us develop a closer working relationship
1	4	Kept us at an arm's length relationship
79	69	No change
17	35	Not sure
3	2	Other (please specify)
X	X	Generate a value analysis
X	X	Corporate effort started in 1993
X		Working closer together in packaging development



Test for $\mu = 0$

	n	Mean	Standard Deviation	T	p - value
With Suppliers	166	.5120	.5133	12.85	0.0000
With Customers	137	.4412	.5546	9.28	0.0000

Relationships with Suppliers

Count Row Percent Column Percent Total Percent	Relationships with Suppliers		Row Total
	Reduction Effort	No Reduction Effort	
Kept at arm's length relationship	0 0.0% 0.0% 0.0%	1 100.0% 1.8% 0.6%	1 0.6%
No change	39 49.4% 35.1% 23.5%	40 50.6% 72.7% 24.1%	79 47.6%
Developed closer working relationship	72 83.7% 64.9% 43.4%	14 16.3% 25.5% 8.4%	86 51.8%
Column Total	111 66.9%	55 33.1%	166 100.0%

$$\chi^2 = 23.965 \quad 2 \text{ degrees of freedom} \quad p = 0.0000$$

Relationships with Customers

Count Row Percent Column Percent Total Percent	Relationships with Customers		Row Total
	Reduction Effort	No Reduction Effort	
Kept at arm's length relationship	1 25.0% 1.1% 0.7%	3 75.0% 6.1% 2.2%	4 2.9%
No change	32 46.4% 36.4% 23.4%	37 53.6% 75.5% 27.0%	69 50.4%
Developed closer working relationship	55 85.9% 62.5% 40.1%	9 14.1% 18.4% 6.6%	64 46.7%
Column Total	88 64.2%	49 35.8%	137 100.0%

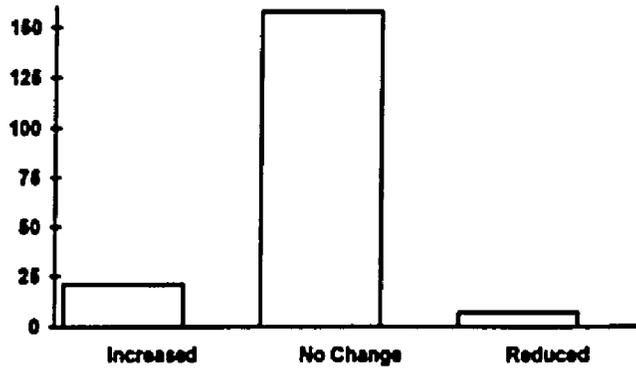
$$\chi^2 = 25.379 \quad 2 \text{ degrees of freedom} \quad p = 0.0000$$

Question #20

Over the last three years, our solid waste reduction efforts have:

		Continue over next three years?	
		Yes	No
n = 186			
21	increased sourcing lead time	15	6
158	not changed the sourcing lead time	131	20
7	reduced the sourcing lead time	7	0

Sourcing Lead Time



Count Row Percent Column Percent Total Percent	Reduction Effort	No Reduction Effort	Row Total
Increased sourcing lead time in last three years	16 76.2% 12.7% 8.6%	5 23.8% 8.3% 2.7%	21 11.3%
No change in sourcing lead time in last three years	105 66.5% 83.3% 56.5%	53 33.5% 88.3% 28.5%	158 84.9%
Reduced sourcing lead time in last three years	5 71.4% 4.0% 2.7%	2 28.6% 3.3% 1.1%	7 3.8%
Column Total	126 67.7%	60 32.3%	186 100.0%

$\chi^2 = .849$ 2 degrees of freedom p = 0.67

Count Row Percent Column Percent Total Percent	Reduction Effort	No Reduction Effort	Row Total
Change in lead time in last three years	21 75% 16.7% 11.3%	7 25% 11.7% 3.8%	28 15.1%
No change in lead time in last three years	105 66.5% 83.3% 56.5%	53 33.5% 88.3% 28.5%	158 84.9%

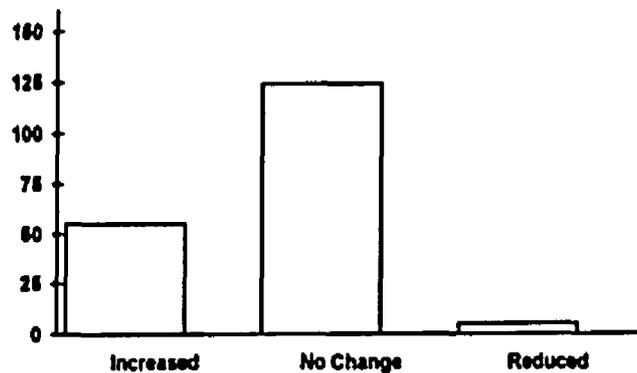
$\chi^2 = 2.156$ 1 degree of freedom p = 0.16

Question #21

Over the last three years, our solid waste reduction efforts have:

n = 184		Continue over next three years?	
		Yes	No
55	increased the complexity of sourcing	49	6
124	not changed the complexity of sourcing	98	21
5	reduced the complexity of sourcing	4	1

Sourcing Complexity



Count Row Percent Column Percent Total Percent	Reduction Effort	No Reduction Effort	Row Total
Increased sourcing complexity over last three years	46 83.6% 36.8% 25.0%	9 16.4% 15.3% 4.9%	55 29.9%
No change in sourcing complexity over last three years	77 62.1% 61.6% 41.8%	47 37.9% 79.7% 25.5%	124 67.4%
Reduced sourcing complexity over last three years	2 40.0% 1.6% 1.1%	3 60.0% 5.1% 1.6%	5 2.7%
Column Total	125 67.9%	59 32.1%	184 100.0%

$$\chi^2 = 9.956 \quad 2 \text{ degrees of freedom} \quad p = 0.007$$

Count Row Percent Column Percent Total Percent	Reduction Effort	No Reduction Effort	Row Total
Change in sourcing complexity over last three years	48 80.0% 38.4% 26.1%	12 20.0% 20.3% 6.5%	60 32.6%
No change in sourcing complexity over last three years	77 62.1% 61.6% 41.8%	47 37.9% 79.7% 25.5%	124 67.4%
Column Total	125 67.9%	59 32.1%	184 100.0%

$$\chi^2 = 5.95 \quad 1 \text{ degree of freedom} \quad p = 0.016$$

Count Row Percent Column Percent Total Percent	Reduction Effort	No Reduction Effort	Row Total
Projected change in sourcing complexity within next three years	55 74.3% 44.7% 30.7%	19 25.7% 33.9% 10.6%	74 41.3%
No change projected in sourcing complexity within next three years	68 64.8% 55.3% 38.0%	37 35.2% 66.1% 20.7%	105 58.7%
Column Total	123 68.7%	56 31.3%	179 100.0%

$$\chi^2 = 1.846 \text{ 1 degree of freedom } p = 0.193$$

Question #22

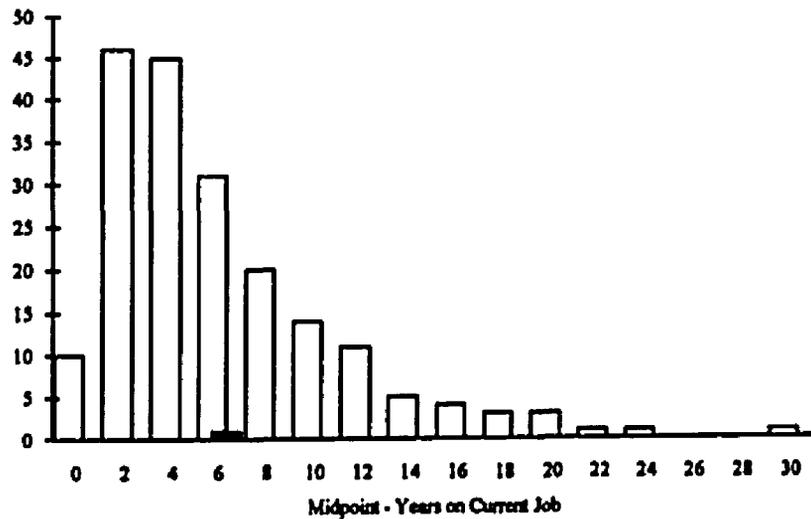
What is your position or title?

n = 198

Director	82
Manager	51
Vice President	36
Senior Buyer	15
Owner/President	5
General Manager	3
Purchasing Head	3
Engineer	3
Executive Assistant - Purchasing	1

How long have you held this position?

Average	5.9 years
Longest	29 years
Shortest	1 month



Question #23

n = 202

Does your company have a on-going solid waste reduction effort?

	Yes	No
	131	71
		Policy
Chemical	n = 84	66.7%
Electronic	n = 63	52.4%
Food	n = 55	76.4%
		No Policy
		32.9%
		47.6%
		23.6%

If the answer to the above question is YES, is your solid waste reduction effort:

n	Yes	No	
120	64	56	A formal, documented effort?
119	83	36	Shared with your suppliers?
120	77	43	Integrated within your procurement procedure?

Policy

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	1.736	0.868	3.90	0.022
Residual Error	199	44.308	0.223		
Total	201	46.045			

Critical test value = 3.34

Industry	Count	Mean	Standard Deviation
Chemical	84	0.6667	0.4742
Electronic	63	0.5238	0.5034
Food	55	0.7636	0.4288

	Chemical	Electronic
Electronic	-0.0429 0.3286	
Food	-0.2903 0.0963	-0.4455 0.0342

Formal

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.716	0.358	1.44	0.242
Residual Error	117	29.150	0.249		
Total	119	29.867			

Critical test value = 3.36

Industry	Count	Mean	Standard Deviation
Chemical	53	0.5472	0.5025
Electronic	28	0.6429	0.4880
Food	39	0.4359	0.5024

Shared

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	0.617	0.308	1.46	0.236
Residual Error	116	24.492	0.211		
Total	118	25.109			

Critical test value = 3.36

Industry	Count	Mean	Standard Deviation
Chemical	53	0.6604	0.4781
Electronic	30	0.6333	0.4901
Food	36	0.8056	0.4014

Integrated

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	1.355	0.678	3.02	0.053
Residual Error	117	26.236	0.224		
Total	119	27.592			

Critical test value = 3.34

Industry	Count	Mean	Standard Deviation
Chemical	53	0.6038	0.4938
Electronic	29	0.5172	0.5085
Food	38	0.7895	0.4132

	Chemical	Electronic
Electronic	-0.1733 0.3464	
Food	-0.4249 0.0535	-0.5496 0.0052

	Count	Integrated in	Not Integrated in	Row Total
	Row Percent Column Percent Total Percent	Purchasing Procedures	Purchasing Procedures	
Formal Effort	38	20	58	
	65.5%	34.5%	51.3%	
	54.3%	46.5%		
No Formal Effort	32	23	55	
	58.2%	41.8%	48.7%	
	45.7%	53.5%		
Column Total	70	43	113	
	61.9%	38.1%	100.0%	

$\chi^2 = 0.644$ 1 degree of freedom p = 0.45

	Count	Shared with	Not Shared with	Row Total
	Row Percent Column Percent Total Percent	Suppliers	Suppliers	
Formal Effort	44	14	58	
	75.9%	24.1%	50.9%	
	56.4%	38.9%		
No Formal Effort	34	22	56	
	60.7%	39.3%	49.1%	
	43.6%	61.1%		
Column Total	78	36	114	
	68.4%	31.6%	100.0%	

$\chi^2 = 3.026$ 1 degree of freedom p = 0.086

	Count	Integrated in	Not Integrated in	Row Total
	Row Percent Column Percent Total Percent	Purchasing Procedures	Purchasing Procedures	
Shared with Suppliers	63	16	79	
	79.7%	20.3%	68.7%	
	87.5%	37.2%		
Not Shared with Suppliers	9	27	36	
	25.0%	75.0%	31.3%	
	12.5%	62.8%		
Column Total	72	43	115	
	62.6%	37.4%	100.0%	

$\chi^2 = 31.662$ 1 degree of freedom p = 0.0000

Question #24

How are each of the following primarily managed?

Procurement	Solid waste	
n = 179	n = 173	
65	45	On a corporate level
39	61	On a local/divisional level
75	67	Both

Procurement

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	8.997	4.498	8.68	0.000
Residual Error	176	91.227	0.518		
Total	178	100.223			

Critical test value = 3.34

Industry	Count	Mean	Standard Deviation
Chemical	75	0.0000	0.7711
Electronic	55	0.0182	0.7815
Food	49	0.5102	0.5448

	Chemical	Electronic
Electronic	0.0182 0.9000	
Food	0.5102 0.0000	0.4920 0.0003

Solid Waste

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Industry	2	1.582	0.791	1.31	0.274
Residual Error	170	102.938	0.606		
Total	172	104.520			

Industry	Count	Mean	Standard Deviation
Chemical	77	-0.1558	0.7958
Electronic	49	-0.1429	0.7906
Food	47	0.0638	0.7344

**Comparison of Responses With
< 3 Years In Position vs. > 3 Years in Position**

Question	< 3 Year	> 3 Years	p - Value
1	0.89	0.67	0.18
2	1.321	1.179	0.16
3	0.07	-0.12	0.25
4	0.589	0.36	0.16
5	1.143	0.949	0.11
6	0.47	0.500	0.82
7	1.000	0.959	0.68
8	1.467	1.328	0.11
9	0.147	0.117	0.83
10	0.720	0.808	0.54
11	0.19	0.12	0.65
12	0.92	0.767	0.21

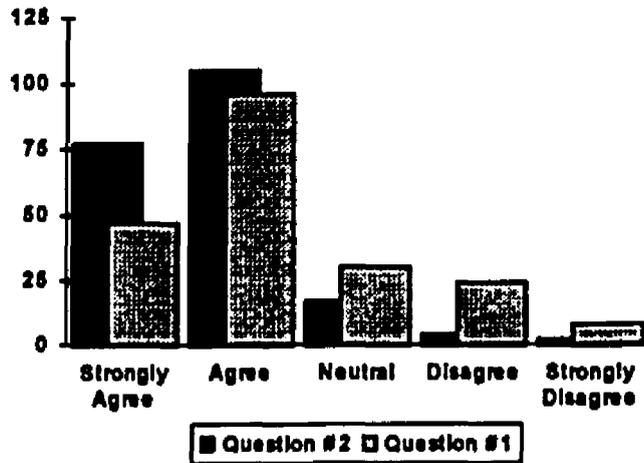
Trends Data

Comparing the Last Three years vs. Next Three Years

Test for μ Question #1 = μ Question #2

	N	Mean	Standard Deviation	Standard Error
Question #1	205	0.732	1.062	0.074
Question #2	205	1.224	0.760	0.053

T	P-Value
-5.40	0.0000

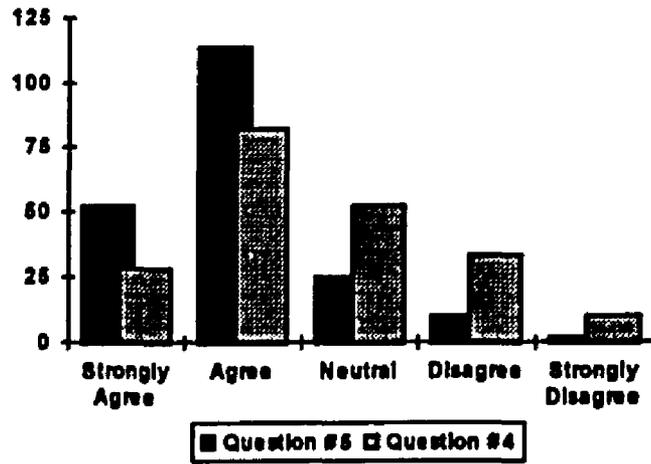


Comparing the Last Three years vs. Next Three Years

Test for μ Question #4 = μ Question #5

	N	Mean	Standard Deviation	Standard Error
Question #4	205	0.415	1.066	0.074
Question #5	203	1.005	0.818	0.057

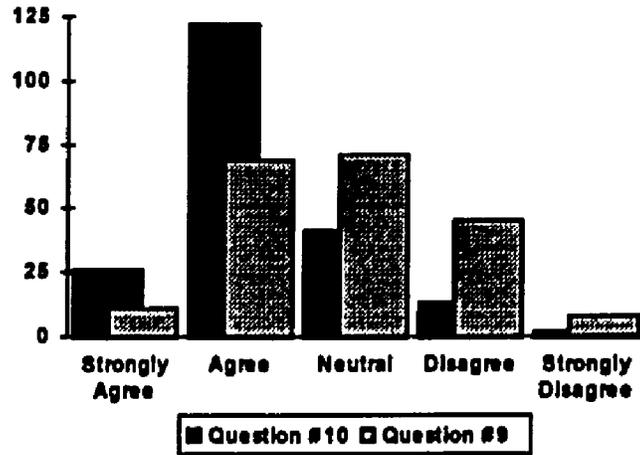
T	P-Value
-6.28	0.0000



Comparing the Last Three years vs. Next Three Years

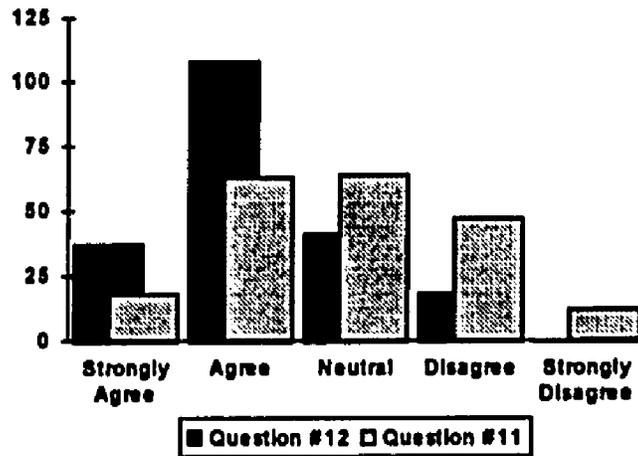
Test for $\mu_{\text{Question \#9}} = \mu_{\text{Question \#10}}$

	N	Mean	Standard Deviation	Standard Error
Question #9	204	0.147	0.956	0.067
Question #10	204	0.770	0.788	0.055
		T		P-Value
		-7.18		0.0000



Comparing the Last Three years vs. Next Three Years
 Test for μ Question #11 = μ Question #12

	N	Mean	Standard Deviation	Standard Error
Question #11	204	0.137	1.060	0.074
Question #12	204	0.804	0.837	0.059
		T	P-Value	
		-7.07	0.0000	



APPENDIX D
INTERVIEW PROTOCOL

In order to focus each case study toward the specific scenario to be investigated, the following interview protocol will be used:

Why did your company start doing something about packaging solid waste?

- **What motivated your actions?**
- **Do you think these factors will change in the future?**
- **If yes, what is being done to address these issues today?**
- **Did the effort utilize an executive champion to help guide the efforts?**
- **If yes, who and why?**
- **If no, do you feel one is required to make this a successful effort?**
- **What areas were involved in deciding the reduction effort?**

What is the role of purchasing in the overall corporate packaging solid waste reduction effort?

- **How did Purchasing get involved in the process?**
- **Should Purchasing be more involved in the process? If so, how?**
- **Do you foresee Purchasing becoming further involved in the solid waste reduction issues at your company?**

How did you determine your solid waste reduction goals?

- **How are these measured?**

When setting up a program, how do you motivate the supplier/customer to come on board

- **How did you determine the goals of the program?**
- **How do you measure success?**
- **How has this impacted your relationship with your supplier/customer?**
- **How do you determine this?**
- **How do you think the relationship will be impacted in the future?**

Who in Purchasing is responsible for the packaging solid waste reduction effort?

- **Why was this person selected?**
- **When was this person selected?**
- **How is performance measured?**
- **How does this person get the rest of the Purchasing group involved in packaging solid waste reduction efforts?**

Have the packaging solid waste reduction effort required new or unique procurement skills?

- **What special skills were required?**
- **How did you develop these skills?**
- **Do you foresee any other skills which may be required in the future?**

What organizational changes have taken place within Purchasing to accommodate packaging solid waste management efforts.

- **When did these changes take place?**
- **What was the primary reasoning behind these changes?**
- **Do you foresee any other organizational changes in the future to support packaging solid waste management efforts?**

How does Purchasing get involved in reducing packaging material which ultimately will go to your customers?

- **How much involvement to you expect in the future?**

How are the Purchasing solid waste reduction efforts measured?

- **Are the results reported? To whom? How often?**
- **Do you feel this will change in the future? Why?**

Many survey respondents indicated the sourcing activity has become more complex as a result of consideration for packaging solid waste reduction efforts. How has this impacted the complexity of your sourcing decision?

- **How do you think this will change in the future?**
- **What tools or tricks have been used to help alleviate the complexity?**

What alternatives have been explored to reduce packaging solid waste?

- **With Customers?**
- **With Suppliers?**

- **Have you considered alternate packaging materials?**
- **Have you considered reduction of packaging materials?**
- **Have you considered reusing packaging material?**
- **What issues or problems have been associated with each alternative?**

Have any recent business cases been conducted which involve packaging or solid waste reduction efforts?

- **How were these business cases conducted?**
- **Will future business cases consider packaging solid waste management efforts? Why and How?**

Do you feel your industry or company is different from others in addressing packaging solid waste?

What would you do differently if you could do it over again?

APPENDIX E
CASE STUDIES

CIBA - Mettler/Toledo Scale

Mettler/Toledo Scale is a \$750 million multinational producer of quality weighing instruments. It is a subsidiary of Swiss parent CIBA-GEIGY. The product line ranges from precision scales built in the Mettler division which have the accuracy to measure molecular weights to the industrial/retail scales built by the Toledo Scale division which have the accuracy to weigh a railcar traveling sixty miles per hour.

The company has eight domestic plants and three plants located in Brazil and China. The company case study specifically investigates the actions within the Mettler/Toledo Scale facilities in Worthington, Ohio. Discussion pertaining to the design review process is effective company-wide.

The case study was initiated by personal contact with the Chief Information Officer, Mr. David Platt, and linked through to Mr. John Lucas, Plant Manager. After initial screening discussions, the case study participants included:

- Mr. Richard S. Keller, Jr.
Purchasing Manager**
- Mr. Joseph Telly
Support Associate**

Data Translation

Data Translation Company is a \$36 million producer of high performance data acquisition, image processing, and multi-media equipment for the IBM PC, PS/2, VMEbus, and other computer platforms. Data Translation uses wholly owned subsidiaries in the United Kingdom, Germany, France, and Italy and distributors in more than 40 countries to service the international marketplace with a standard five-day delivery and quality guarantee.

The case study was initiated after the Director of Materials indicated on the mail survey that the company was willing to participate in a case study. After initial screening discussions, the case study participants included:

- Ms. Kim Gray
Director of Materials
- Ms. Lori Dustin
Director of Sales
- Mr. Dick Mercadante
Facilities Manager
- Ms. Mary Butler
Senior Buyer

E. I. du Pont de Nemours & Company

E. I. du Pont de Nemours & Company (DuPont) is a \$38 billion multinational producer of chemicals. It is the largest chemical company in the United States. The chemical segment manufactures commodity and specialty products including titanium dioxide, fluorochemicals, and polymer intermediates. A diversified mix of specialty fibers is produced to serve end users such as high-strength composites in aerospace, active sportswear and packaging. Polymer operations consist of engineering polymers, elastomers, and fluoropolymers. Petroleum operations consist of both upstream and downstream activities. Diversified businesses include agricultural products, coal, electronics, imaging systems, and medical products.

The case study was initiated after the Vice President of Materials & Logistics Services, Mr. Frank J. Nagy indicated on the mail survey that the company was willing to participate in a case study. After initial screening discussions, the case study participants included:

- Mr. Robert Weis
Manager - Environmental Packaging Initiatives**
- Ms. Kim D. Steele
Information Systems Project Manager**
- Ms. Maria Ulissi
Procurement Training Leader**

International Business Machines

International Business Machines Corporation is a \$64 billion multi-national producer of information processing equipment and systems. It has business units manufacturing processors, general purpose processors, networks, operating systems, supercomputers, printers, workstations, personal computers, tape drives, optical storage devices, logic and memory chips, and developing business solutions.

IBM installed the IBM Worldwide Distribution Engineering Center to support corporate packaging efforts. The Center develops guidelines for IBM engineers and IBM suppliers to achieve continued optimal use of packaging materials.

The case study was initiated through Mr. Edward Collins. Mr. Collins arranged for the initial survey to be filled out by Mr. Alvin Voss, Senior Engineer at IBM's Worldwide Distribution Engineering Center. Mr. Voss indicated on the mail survey that they were willing to participate in a case study. After initial screening discussions, the case study involved:

- **Mr. Alvin R. Voss
Sr. Engineer - Worldwide Distribution Engineering
Services**

Rich Products Corporation

Rich Foods Products is a multi-national producer of food products with headquarters in Buffalo, New York. Company growth has been achieved through acquisition and international expansion. Revenues have grown from \$715 million in 1989 to \$890 million in 1991. The revenues for 1992 exceeded \$950 million. Over the same period of time the number of employees has grown from 4,900 to 7,000.

The company primarily produces frozen foods that are typically maintained at below 0° F. Products include non-dairy products, whipped topping, frozen bakery products (except bread), frozen and prepared shrimp, frozen crab meat, spaghetti and meatballs, packaged ice cream, pudding pops, and quick frozen and cold pack fruits.

The company has twenty-two manufacturing plants and facilities, six U.S. offices and four foreign offices. It conducts business in over 50 countries. Subsidiaries include Booth Seafood, Byron's, Casa Di Bertacchi (Italian Food Specialties), S. Gumpert (Gelatin Desserts, Puddings, and Cake Mixes), Rich Fruit Pak, Rich Products - Columbus (Non-Dairy Creaming Agents, Vending Powder Soups), Rich Food Products - Dayton (Pies and Cakes), and Rich SeaPak (Fish, Shrimp, Seafood Specialties, Onion Rings, and Vegetables). The company also operates an Entertainment Group that owns three minor league sports teams and four radio stations. Rich Transportation Services is a wholly owned subsidiary that provides for-hire frozen food trucking services.

In each of the last ten years, Institutional Distribution Magazine's annual "Industry Leaders Roll" has ranked Rich Products either first or second in their class.

The case study was initiated through Mr. Donald J. Allison of Computerized Packaging Consultants. He suggested contacting the Vice President of Logistics, Mr. Jack T. Ampuja to see if the company was willing to participate in a case study. After initial screening discussions, the case study participants included:

- Mr. John J. Nobile
Corporate Purchasing Manager
- Mr. Howard W. Wurster Jr.
Manager of Corporate Packaging
- Ms. Mary Beth Kuryak
Packaging Coordinator

Rohm and Haas Chemicals

Rohm and Haas Company is a \$3 billion multinational producer of specialty polymers and biologically active compounds. It is the largest manufacturer of acrylic plastics. It also produces polymers, resins, and monomers which are geared toward a wide variety of industrial applications. The company also manufactures agricultural and industrial chemicals.

The Rohm and Haas annual report states its business strategy is to "make value-added products for uses where product tailoring and superior customer service provide a competitive edge." Two-thirds of sales are related to acrylic value-added chains, the remaining one-third of sales consists of four stand-alone businesses -- agricultural chemicals, biocides, electronic chemicals, and separation technologies.

The case study was initiated after the Director of Materials Management, Mr. David T. Espenshade indicated on the mail survey that the company was willing to participate in a case study. After initial screening discussions, a case study was conducted with:

- Ms. Karen W. McDonie
Manager - Purchasing Packaging Services

Tastykake

Tastykake is the principal division of Tasty Baking Company. Located in Philadelphia, Tastykake is a \$128 million manufacturer of snack cakes, pies, cookies, and doughnuts.

The case study was initiated after the Vice President of Purchasing, Mr. Owen Morris Jr., indicated on the mail survey that the company was willing to participate in a case study. After initial screening discussions, the case study participants included:

- **Mr. Joseph Bauer
Director of Logistics**
- **Mr. Bruce Maul
Superintendent of Environmental Sanitation**

Company "A"

Motivation

Motivation for solid waste management at Company "A" has come from:

1. Proposed legislation
2. Requirements in the international arena
3. A few customer requests

The primary packaging commodity used are drums. The drum suppliers have proactively developed some solutions to help keep the drums out of the landfills.

Company "A" has reduced the amount of packaging material through lightweighting, changing packaging materials, reuse and refilling Intermediate Bulk Containers (IBCs). In some cases, the company has moved from bags to water-soluble pouches. A cost analysis of changing from drums to IBCs was difficult to justify due to expensive IBC containers and high return freight costs. There is also an issue of passing along the increased cost (to purchase reusable containers) to the customer.

Corporate Efforts

Company "A" is perceived as both reactive and proactive.

- A reactive perception typically comes as a result of customers being reactive to solid waste efforts; due to pressures such as increase landfill tipping fees
- A proactive perception typically comes as Company "A" implements environmental changes before they have been requested by the customers

Company "A" has placed environmental efforts at the plant level and the effort is championed at the executive management level. The company literature indicates a high level of effort and awareness primarily addressing emissions of more than 300 chemicals to air, water, and soil. For packaging material, Company "A" maintains an effort out of Corporate Packaging Services which facilitates the flow of realistic waste management information on costs and logistics to inform customers how to handle packaging waste. Examples of solutions offered to customers include:

- Utilizing a third party (Van Leer) reconditioning program. Van Leer offers an 800 number that allows them to set up route planning to provide feeder of drums to 13-14 conditioning facilities across the United States. The customer calls for pick-up and pays a fee (typically up to \$3 per drum). Company "A" is not involved in the

process other than to provide information to the customers about disposal options.

- Sonoco offers a Mobile Environmental Recycling Vehicle (MERV) which is routed to the location of fiber drums, strips off any metal before grinding the fiber for concentrated collection and transportation to a processing center. Cost runs between \$1.50 and \$3.00 per drum. Again, Company "A" only provides information about this program to the customer.

The perceived solution by Company "A" is in the eventual development of a meaningful reverse logistics infrastructure that adds value to the process. The role perceived by Company "A" is to play an on-going supportive role, not to create solutions, but to stay closely tuned to the alternatives as they develop and facilitate communication between customers and third party suppliers of waste management solutions.

Current efforts are undertaken by Packaging Services, which is a part of the North American Purchasing organization reporting to the Director of Materials Management. Solid waste reduction efforts are not formally recognized but the head of Packaging Services has taken the responsibility to reduce packaging waste as part of the inherent definition of the department. Buyer performance plans include the responsibility to reduce packaging solid waste. Specialized training involves enlightening buyers through knowledge of current and pending legislation.

The Marketing function of Company "A" does not take a strong interest in the effort to help reduce customer solid waste although there has been an increase in the number of customers asking about solid waste reduction. Packaging Services is attempting to proactively address solid waste issues so the company will be ready as the issue increases in importance. Success of the program is largely dependent on marketing involvement selling the program to customers. Lack of business interest has hindered reduction efforts throughout the entire channel.

Measurement of Improvement

Company "A" is trying to track outbound packaging material but finds it is difficult to collect meaningful data. They can determine the number of items going out but are having difficulty determining what really happens to the material after it enters the customer's hands. This has created difficulty in accurately analyzing the overall environmental benefits of changing to IBC or utilizing recycled pallets. The lack of accurate data has hindered setting accurate goals.

Results are not formally reported up the chain of command, reflecting a "lack of caring" by upper management. It is likely this would change if the company faced financial penalties or a significant increase in the number of customers requesting solutions.

Expectations for the Future

- 1. Continued emphasis to reduce waste**
 - **From customers - due to landfill space issues and increasing disposal costs**
 - **From suppliers - as awareness increases**
- 2. Some states will continue to push more legislation**
- 3. The Council of Northeast Governments will move more toward a reasonable joint effort working with industry**
- 4. Continued development of third party solutions**

Company "B"

Company "B" has a complex set of diverse products primarily serving industrial customers throughout the world with multiple channels. It has benchmarked its activities with Johnson & Johnson, Eastman Kodak, Hewlett-Packard, and IBM to help understand what is being done and what Company "B" should be doing. In August 1992, it set up a Center of Excellence to address the issues.

Goals

Company "B" sends an annual environmental progress report to stockholders along with annual financial report. While past environmental progress reports have not addressed packaging, the 1993 report will include packaging solid waste reduction efforts.

The company has set a goal of reducing what ultimately goes into landfills by 50% by the year 2000 of the amount sent to landfills in 1991. The 50% goal is not indexed for changes in business volume. If company business doubles, solid waste reduction must be reduced by an even greater factor. While 1991 is a base measurement year, Company "B" has already reduced over 100 million pounds of waste from efforts starting as early as 1985. While no credit is given for efforts prior to the 1991 base year, the company still wants to communicate that they are already doing something to reduce solid waste.

The following interim targets have been set:

Company "B" Interim Reduction Targets

Year	Reduction
1991	Base Year
1995	25%
1998	35%
2000	50%

Strategies

Company "B" has developed the following strategies revolving around the 3R's (Reduce, Recycle, Reuse) plus a 4th "R" to buy recycled materials whenever possible. The strategic approach by Company "B" is to play an active role in all aspects of the supply chain by involving customers, suppliers, internal operations, and to close the loop by helping to create a market for recycled products through corporate purchasing efforts. Strategies include:

- Avoid and/or reduce materials through lightweighting and increasing material efficiency, utilizing larger bulk or semi-bulk shipments, using self-destructing packaging that is dissolvable or consumable, and removing heavy metals such as lead, cadmium, mercury, or hexavalent chromium from all packaging.

- Promote reuse through development of returnable packaging systems for agriculture, chemical, electronic, and fiber divisions and utilizing returnable pallet and bulk box systems.
- Design modification for recyclability and establishing customer/supplier relationships. Company "B" encourages customers to send their packaging material back to Company "B" suppliers. Company "B" then repurchases the retromanufactured material from the suppliers.
- Support the use of recycled content to utilize the highest percentage of post-consumer recycled content practicable for packaging needs. This will help develop markets for recycled products by creating a demand.
- Reduce disposal by diverting as much packaging waste from incinerators and landfills as possible.

Efforts are initially directed in 1993 on outbound shipments to Company "B" customers. Efforts concerning inbound shipments from suppliers are targeted to begin in 1994.

Measurement

To facilitate measurement and tracking the reduction effort, Company "B" set up a special project in April 1993 to develop a computerized reporting system. The reporting system is currently in its infancy stage. Efforts to date have been spent reviewing the scope of the

project and developing options to provide the most efficient and accurate measurement of the reduction efforts. The design of choice will not require a transaction-based program but a simplified program that can be run as needed, captures 90% to 95% of the material flow, and is adaptable to changing reporting requirements.

The system design utilizes generic Bills Of Materials (BOMs) for packaging finished product ("put-ups.") Company "B" has over 10,000 unique BOM put-ups. Manpower estimates indicated over ten man-years of effort would be required to collect and input unique put-up data. Use of generic BOMs significantly reduces the amount of data required. Four or five generic BOMs can be used to represent roughly 200 to 300 unique BOM put-ups per plant. Overall, this means a total of approximately 230 BOMs will be used in place of the 10,000 unique BOM put-ups. Plans currently call for on-line capability of update the generic BOMs as needed.

A pilot program involving the top 30 customers of Company "B" is identifying how much packaging material has been sent to each customer and is investigating what the customer has done with the packaging material after they received it. The top thirty customers represent 50% of the total volume of packaging material used by the company. The pilot program hopes to determine the scope and magnitude of the reduction task, determine return needs, and hopefully identify potential leverage points to help achieve reduction goals.

The reporting system will be utilized internally, with suppliers, and with customers. Internal reports will be generated which identify how business teams are performing relative to their goals, provide information for the environmental annual report, and facilitate government reporting requirements such as the Council of Northeastern Governments. Packaging suppliers may utilize the information to understand the flow of packaging material and sources of reusable materials. In some cases, Company "B" utilizes third party collection programs and must pay an estimated fee for the projected number of units to be shipped. The reporting system will be utilized to reconcile the account with actual shipment data. Reports will be used with key customers to identify disposition of packaging material which potentially may result in reuse or inclusion of the material in the return loop to Company "B" packaging suppliers.

Purchasing Organization and Policy

Company "B" has corporate buyers for pallets, tubes, and drums. Each regional office buys at the local level. In May 1990, Company "B's" Executive Committee created the following corporate procurement policy:

"Resolved, that in furtherance of Company "B's" commitment to its waste management policy, it is the policy of Company "B" to preferentially purchase items made of recycled materials where such products meet our continuously improving quality requirements and are available at reasonable prices and terms."

Purchases are driven by the following packaging guidelines "to use the highest percent of post-consumer recycled content practicable in outbound (product) and inbound (supply) packaging materials."

Company "B's" Guidelines for Recycled Content

Material	Recycled Content
Corrugated Boxes	35%
Paperboard Cartons	80%
Paper Tubes and Cores	90%
Plastic Bottles	25%

Efforts involving outbound packaging material shipped to customers include:

- Lightweighting packaging materials.
- Certification that packaging materials do not contain lead, cadmium, mercury, or hexavalent chromium.
- Recommendations for enhancing the recyclability of current packaging materials.

- **Expanding "Closed Loop" recycling partnerships with customers and package suppliers.**
- **Registering/qualifying packaging for German return systems.**

Efforts involving inbound packaging material shipped from suppliers include:

- **Developing proactive reduce, reuse, and recycle programs with suppliers to assist Company "B" plants in meeting their environmental goals to reduce inbound (supply) packaging waste by at least 50%.**
- **Determining the quantity (in pounds) and recycled content (post- and pre-consumer) of packaging materials used to deliver products to Company "B" in 1991.**
- **Determining the quantity (in pounds) of packaging materials sold to Company "B" in 1991.**
- **Certifying post-consumer and pre-consumer recycled content of packaging materials sold to Company "B" in 1991.**
- **Forecasting post-consumer and pre-consumer recycled content levels that package suppliers expect to offer in 1995 and 2000.**

Personnel Training

Training of personnel concentrates primarily on awareness of the issues, regulatory issues and requirements, company policies and goals, what has been accomplished to date, and how the company benchmarks against others.

Company "B" utilizes an education coordinator to act as a resource to help structure and develop training courses for the 1500 to 2000 purchasing personnel corporate-wide.

Employees cited increasing involvement by purchasing throughout the company and the need to develop leadership skills and improve skills in operating as a team. In addition, the environmental effort needs to train marketing personnel to include environmental efforts when interfacing with customers.

Issues

The key issue faced by Company "B" is how to best communicate efforts internally to employees and externally to customers and suppliers. Packaging tends to be a low percentage of the total product cost and does not traditionally get much emphasis, particularly with industrial customers.

Company "C"

Company "C" considers itself proactive with both customers and suppliers. Its first environmental corporate policy was formally published in September 1974. On-going efforts are conducted at each location by packaging engineers with help from the site solid waste coordinator. All efforts are under the guidance of the corporate Director of Logistics Processes.

The company has appointed Environmental Coordinators at each company location, established recycling sub-committees, modified supplier packaging and material handling specifications, implemented a packaging competition program, expanded U.S. goals worldwide to all manufacturing and sales locations, established a corporate task force to study reclamation of packaging from customers, and established a packaging competency center.

The Distribution Competency Center originated in 1975 to support both distribution engineering and packaging engineering. It has gone through several mission transitions but is back to its original role. The Center develops corporate packaging specifications for purchasing use at each company location. The specifications are now available on-line to help accommodate changes and support ISO 9000 requirements.

Measurements

By being proactive, corporate solid waste management goals were achieved early and are currently twice the EPA proposed targets. Some international locations are having difficulty meeting these goals due to lack of local recycling capabilities and national goals.

Company "C" has investigated measurement programs of other companies but has not found anything usable that links into its existing database. In 1990, the company manually collected environmental information about the weight and volume of packaging material used, whether it is recyclable, the content of heavy metals, or Chlorofluorocarbons (CFCs) utilized in each location. It is currently testing a VM-based executable file which will facilitate the reporting process. Purchasing is involved by collecting supplier information, particularly heavy metal certification. In addition, the company has undertaken a benchmarking study with competitors to help refine its guidelines.

Internal Packaging Competition

Company "C" has developed an internal environmental packaging award which helps encourage participation, recognize participants, and attach monetary value to changes which improves its environmental packaging. Points are awarded for packaging changes, team development, and use of new technology. The annual competition presents site and individual awards.

Customer Feedback

Company "C" receives more letters or comments on environmental concerns from the customers of less expensive, consumable products.

Supplier Support

Company "C" provides a document to all suppliers outlining packaging and handling requirements for doing business with the company and has included an environmental section within the document. The company has developed Environmental Design Guidelines for Company "C" Packaging Engineers and makes it available to suppliers or customers upon request. The company was also very active in developing the Handbook for Environmentally Responsible Packaging in the Electronics Industry. These materials are used to help simplify the job of the buyer by providing a technical reference to understand the terminology, identify third parties to facilitate environmental efforts, provide guidelines such as when to utilize reusable containers, and identify packaging alternatives. Care must be taken by Purchasing to see that packaging costs do not end up in the piece price, but can be separately identified in supplier costs.

Company "D"

Company Policy

Decisions made at Company "D" are not entirely financially driven as the company has a corporate philosophy of wellness and greenness that pervades the decision making process. For example, when changing equipment to end the use of Chlorofluorocarbons (CFCs), Company "D" chose to go beyond environmental requirements and install new equipment that far exceeded the standard for emissions.

Interaction with Customers

Efforts for packaging reduction are driven by Company "D's" manufacturing operations. The company ships final products to subsidiaries, distributors, and directly to customers. Due to the technical make-up of the products, customers often communicate technical requirements and feedback directly to the manufacturing location. Occasional requirements for special packaging is communicated directly to Shipping as an order qualifier.

Some OEM customers have requested reduction in the amount of documentation sent with the product.

Two European subsidiaries have requested information (what was being done and when it would happen) concerning company efforts on environmentally safe packaging. In addition, company products are shipped by air to European customers. Air freight charges are based on size instead of weight creating economic reasons for reduction of packaging material on all international shipments.

Company "D" has not utilized its environmental efforts for green marketing purposes. This is not one of the primary order winners making the sale.

In-House Effort

Company "D" was acknowledged by the Massachusetts High Tech Council for environmentally sound packaging and trash disposal. They have an active internal collection system for bottles and papers reducing solid waste disposal costs by collecting and pre-sorting drink bottles and three types of paper (office white, computer green bar, and newspapers). The cost to dispose of solid waste costs Company "D" \$75 per ton. Collected paper is picked up by a third party at a cost of \$38 per ton, a reduction of \$37 per ton. Drink bottles are collected and transported weekly by company van to a downtown recycling center.

Other in-house solid waste reduction includes allowing and encouraging suppliers to take excess pallets from a designated location regardless of the number originating from that supplier. Styrofoam peanuts from inbound shipments are reused for outbound shipments. Improved corrugated packaging has reduced the amount received from suppliers.

Reuse of plastic tubes holding Integrated Circuits (ICs) has been attempted but harmful static electricity has been a concern.

Disposal options continue to surface. An example was cited regarding specialized disposal of printing ink. After considering traditional disposal options, Company "D" contacted the supplier who offered to pick up the ink for retromanufacturing.

As a matter of practice, Company "D" attempts to source locally whenever possible. This has offered an unexpected benefit of providing a short enough channel to make it feasible for suppliers making their own deliveries to pick up their packaging materials after the product has been delivered.

Measurements:

No specific goals have been put into place. A need was cited for more specific costing of overhead, including identification of how much overhead is packaging related. This would help provide a better handle on the total cost of acquisition instead of solely unit price.

Partnership relationships with suppliers coupled with Company "D's" philosophy to be "the best customer to a shrinking number of suppliers" has resulted in improvements beneficial to both companies. While efforts typically originate from Company "D," an example was cited where a supplier made three additional improvements to the process after Company "D" got the ball rolling. Company "D" initially asked the

supplier to take back boxes. The supplier effort evolved into shipment of the products using reusable totes.

Company "D's" efforts are also forward-looking. Their supplier of printed manuals has a standing request to notify the company when it is economically feasible to print on recycled paper

The European mandate is changing how purchasing buys products. For example, the company currently ships a vinyl binder with documentation. Company "D" is aware that it must be prepared to pay for return of the binder sometime in the future. It is addressing alternatives such as utilizing alternative materials such as hard paper or eliminating the binder entirely by shipping diskette soft copy documentation.

The company is proactive in dealing with suppliers but admits it has been somewhat reactive in accommodating customer environmental requirements in that it did not anticipate the environmental requirements before they were requested.

When asked what they would do differently if they could do it over again, the responses suggested acting sooner and selecting more suppliers moving in the same direction as Company "D."

Company "E"

Company "E" is an example of a company that has begun managing its solid waste as a result of state government reporting requirements. Companies generating more than two thousand pounds of any specific type of trash are required by state government environmental regulations to provide a biannual report documenting what the company puts into the solid waste stream and where it goes. An annual audit is also required. A copy of the audit is sent to the company's third party waste hauler who must get approval to dispose of the waste. Company "E's" solid waste has been classified as 'municipal-like,' that is, waste similar to residential waste. This classification allows Company "E" to avoid costly chemical analysis of the solid waste. The state government also requires the company to maintain a written source reduction plan spanning a five year period and to have it available upon request.

Measurement

To meet state government reporting requirements, Company "E" started conducting quarterly audits of the content of its solid waste early in 1992. Each audit provides detailed information separated by manufacturing department, environmental sanitation, cafeteria, technical services, mechanical, and direct marketing areas. Production departments represent the greatest percentage (46.8%) of solid waste. The solid waste consists of wraps, cartons, pie boxes, cardboard, separators, and both salable and damaged product.

Solid waste removal costs \$0.0325 per pound. Alternative removal of separated material costs \$0.01 per pound. One of the audit findings is that while the company has a program to reduce waste, there are still additional opportunities for solid waste reduction. The latest quarterly audit provided by the company indicated that out of 37,215 pounds of solid waste generated in one week, 1,520 pounds of finished product and corrugated packaging was removed from the solid waste stream during the audit for alternative processing. This represents an additional opportunity to reduce annual solid waste removal costs by \$1,778.

Goals

Company "E" originally developed a set of "realistic but conservative" solid waste reduction goals to meet the state government requirement to have a five year strategic plan for solid waste reduction. The company has been pleasantly surprised to find their solid waste reduction efforts have dramatically exceeded their goals. Given the cost effective success of their efforts, the company indicated it should have considered working on solid waste reduction long before being required to by the state government. The company was surprised to find that, when using a cost per pound metric, the most expensive component of the finished product was the packaging material.

Efforts to meet the corporate goals are overseen by the Superintendent of Environmental Sanitation. A corporate committee is used to address solid waste reduction efforts and a corporate mission statement on solid waste management was created in 1992.

Solutions

Company "E's" solution to solid waste reduction involves the entire supply chain. It maintains an on-going effort involving suppliers, manufacturers, and customers to continue seeking additional opportunities for improvement. Some opportunities for solid waste reduction have run into cost issues that cannot be resolved within the immediate supply chain. An example was cited in which the closest company willing to accept the waste material for retromanufacturing was located 1,400 miles away. The retromanufacturing company will only take large shipments of the material. This means that Company "E" must accumulate the material at its site until it has 30,000 pounds. The transportation cost to send the material to the retromanufacturer is approximately \$1,900. The alternative solution is to landfill the material at a cost of \$975. Until there is a closer retromanufacturer to accept the material, it is not cost effective for Company "E" to do anything but landfill the recyclable material.

Working With Suppliers

To reduce the amount of inbound packaging material that would enter Company "E's" solid waste stream, meetings were conducted with suppliers to analyze how Company "E" received product from the suppliers and to review the amount of packaging material used to ship product by suppliers. The review discovered a series of changes made by suppli-

ers over time to the inbound packaging had resulted in over-packaging. Each packaging change (such as adding dividers, shrink wrapping, or use of special glues) was added on its own merit and either increased the amount of packaging material shipped or complicated potential recycling efforts. Company "E" has jointly worked with suppliers to reduce the amount of packaging used. Packaging changes have been well received by suppliers. Examples of packaging changes include:

- Utilizing reusable totes for fruit shipment. The totes have simplified the handling of incoming fruit products, reduced packaging costs, and eliminated packaging containers from Company "E's" solid waste stream.
- Company "E" worked closely with their supplier of polypropylene film to change the content of the material used for the cores on which the polypropylene film is wrapped. Polypropylene film is used to wrap many of Company "E's" finished products. The film supplier originally used paper cores that weighed 4 to 6 ounces each. After using the film, the paper cores were thrown into Company "E's" solid waste stream. The supplier is now utilizing reusable hard plastic cores that can easily be shipped back to the supplier.

Working With Customers

Company "E" has been responsive to customer requests to modify the packaging of finished goods. While their primary customers are the distributors and retail outlets where their product is sold, Company "E"

also solicits and acts on the opinions of the final consumer. All feedback is individually considered and receives a response directly from the company. As an example, a consumer contacted the company regarding a perceived overpackaging of a final product that used metalized film and a polystyrene tray. In response to the initial feedback, the company modified its final packaging to minimize the packaging.

Company "F"

The parent of Company "F" is a multi-national chemical company which has been very conscious of the environmental impact of their businesses. The desire to be a "green" company has permeated throughout the corporation in terms of environmental policies and employee attitudes toward the environment.

Design Review Process

The corporation has a five step design process which includes a steering committee review of each new design to "confirm the environmental impact...and to address and resolve any [environmental] issues." The review process considers emissions, safety, and the environmental aspects of the design on the same basis as cost and design issues.

Packaging Reuse

The company has employed a packaging reuse concept similar to that of the apocryphal tale¹⁸⁶ of Henry Ford:

¹⁸⁶The Henry Ford Museum is "unable to substantiate the story,...and considers the story to be doubtful." The June 7, 1971 Detroit News (page 15-A) quoted automobile worker John L. Naylon regarding this tale:

"To us 'old folks' who spent years in the field and at Ford plants, this shipping crate story is one we have guffawed about over the years. I used to be at the Kansas City plant -- first one to ever assemble a Model T outside of Michigan. Lot (sic) of other industrial plants also were in the area. One of these used to ship materials to the Ford plant. The wood in the crates was good sturdy woo -- maybe even oak.

Henry Ford provided precise specifications to his suppliers to ship automobile parts using wooden crates with drilled holes in specified locations. Ford reportedly reused the wood from the crates for the floorboards of the Model T. The specified holes accommodated the gear shift and pedals.

Company "F" designed inbound packaging specifications for a steel stainless shell shipped by a supplier. They found an acceptable source of packaging material meeting the specifications and then told the supplier of the shell where to buy the packaging materials. After the stainless steel product shell is filled with internal electronics by Company "F," the same packaging material is used to ship the final product to customers. Not only has this resulted in an estimated product cost reduction of \$10 for the packaging materials, it has also reduced the costs to dispose of the inbound packaging material and procure and receive new outbound materials. The elimination of the additional amount of packaging material has also reduced the amount of required floor space.

The company reuses corrugated boxes for internal shipments to sister plants. The reuse and reduction of cardboard was initiated when looking for an alternative to purchasing a baler. They are able to reuse corrugated packaging approximately 11 times. In addition, the company reuses plastic anti-static containers for internal shipments. The return of containers are facilitated through use of a dedicated company-owned truck operating twice a week on a closed loop between domestic plants.

Anyway, one of the Ford supplier plant managers was Ralph Settles. He told me that they had received word from Ford that boxes had to be a certain size, width, and length. The reason was that, after receiving them, they were cut up and used as floor boards."

Employee Involvement

There are no quantitative solid waste reduction goals. Employee efforts are driven through the company culture. All employees operate under "directed autonomy" to create new ideas and raise the consciousness with suppliers to encourage involvement and improvements. Floor employees recently raised an environmental issue concerning disposal of hazardous materials. The employee awareness came as a result of Material Safety Data Sheets identifying hazardous materials in the work areas. The manufacturing process utilizes a lead solder which is packaged in a tin tube. The tin tube packaging contains a residual amount of lead after the tube has been used. Proper disposal of spent tin tubes has become a concern. When the supplier was contacted, they suggested Company "F" contact the local EPA office for guidelines regarding proper disposal. The supplier is not interested in taking the spent tubes back even though numerous customers have requested they do so. Purchasing has become involved to help resolve the issue. This is typical of the employee motivated efforts.

Cost Factors

The cost to dispose of solid waste was also one of the initial influences in Company "F's" effort to reduce solid waste. Local landfill costs have risen by an estimated two times over the last three years.

Over a two year period, the company reduced the amount of their solid waste tipped into the local landfill by 47%. This has been achieved primarily through efforts to separate cardboard and office paper from the solid waste stream. Approximately 45% of the solid waste was

cardboard. Another 15% is office paper related. The company now separates these two commodities into bins for separate handling. Tipping fees currently run approximately \$500 per 11 cubic foot container. Company "F" now tips seven less containers per year than they did two years ago.

Green Marketing Opportunity

Solid waste reduction efforts are also partially driven by opportunities for green marketing. Many of their customers are in the food industry and a reduced packaging is sometimes a part of the specified requirements to do business with these companies.

Purchasing Involvement and Skills Requirements

Purchasing activities are organized by commodity. The importance of packaging material varies by commodity. Company "F" uses an in-house consultant to provide support for many different functions and for many different activities including solid waste reduction and meeting EPA requirements. Purchasing also utilizes an environmental "council team" to address environmental issues.

Supplier-customer relationships have drawn closer over the years due to many factors including joint effort on environmental concerns. Company "F" indicated the need to have a close working relationship with suppliers to achieve solid waste reductions. The company has a strategic goal to reduce its supplier base from 900 suppliers to 200 suppliers over the next 18 months to help achieve closer working relationships with fewer suppliers.

Company "F" reports many suppliers have indicated this is the first time solid waste reduction has been mentioned to them by a customer. This indicates to Company "F" that it is out in front of the effort, at least with regard to other companies utilizing the same suppliers.

The company recognizes the need to further develop purchasing skills to become technically competent in their purchases, know what questions to ask, and to be able to correctly and effectively assess responses.

Company "G"

Company "G" utilizes a total supply chain approach to manage the total cost and service of the supply chain from the raw source to the final consumer. The Materials organization supports inbound and outbound material flow and includes departments for Purchasing, Inventory Control, Transportation Services, and Customer Service.

Motivation

The overall objective driving the packaging reduction effort is to reduce cost in order to become more competitive. The positive impact to the environment and solid waste reduction is a secondary benefit. The green movement came through the industry about two to three years ago and was driven through the retail markets. The company expects the green movement to resurface and become more of a concern as more customers ask about it and government regulations require changes. However in an industry of small profit margins, lowest cost remains the primary order-winner.

Company "G" addresses specific industrial and consumer marketing niches. Recently a number of larger companies have started to enter these marketing niches and are perceived to have deeper pockets and a better ability to reduce overall total cost. This has caused Company "G" to proactively address cost reductions in every aspect of their operations including seeking improvements in the utilization of primary, secondary, and tertiary packaging.

New Ways of Working with the Supplier Base

In the past, Company "G" single sourced suppliers due largely to time constraints. The company has recently started an Alternate Sourcing program to increase supplier competition as a means to help reduce costs. It hopes to use free-market competitive forces to achieve cost competitive prices from its suppliers. In addition, the new suppliers considered are providing additional expertise. As a result of the Alternate Sourcing program, the expectations of suppliers have been increasing. Suppliers are asked for more technical input earlier. For example, a sample carton will still be designed internally, but suppliers are asked as part of the quotation to provide creative ideas to improve the base design.

Company "G" uses centralized sourcing and de-centralized buying. Up until two and a half years ago there was only a single person to handle the corporate purchasing. Corporate purchasing now utilizes three employee associates to achieve more sophisticated and complete sourcing activities.

Outsourcing Packaging Improvements

Due to the earlier lack of manpower, Company "G" chose to utilize a packaging consultant. The consultant was used to address current and older products. From more than 2,000 Stock Keeping Units (SKUs), the consultant selected the twelve items having the biggest volume. The following variables were determined for each item:

- Annual volume
- Case costs
- Primary packaging costs
- Average inventory
- Transfer freight costs
- Warehouse costs
- Handling costs
- Shipping freight costs
- Pallet costs
- Case counts per year
- Weight per year

The consultant then utilized a proprietary computer optimization program to consider the relationships of each component in the distribution channel, the design mode, arrangement patterns used, appropriate case counts, the amount of necessary slack (length and width), allowable vertical dimensions, pallet patterns and effective strength for various options (such as use of an interlocking pattern or a combination of a column plus shrink wrap), opportunities for alternative packaging (such as use of a slip sheet instead of a pallet), allowable pallet overhang, allowable stack height throughout the entire distribution channel, appropriate use of dividers, and optimal utilization of flaps and corners to add strength to the packaging.

Changes were recommended to the overall process. Subsequent savings have been achieved as a result of optimizing the entire process. As shown below, packaging may be only 15% of the total logistics cost, but the packaging design can impact the cost of many other logistics activities.

Company "G's" Logistics Costs

Activity	Percentage of Total Logistics Cost
Packaging	15%
Transfer Freight	8%
Shipping Freight	35%
Warehousing	42%

The logistics operations (packaging materials, warehousing, and shipping) for the initial twelve SKUs analyzed accounted for annual costs totaling \$15,245,058. The consultant identified potential changes that projected annual savings of \$1,977,507 (13%). These changes included reduction of slack and pallet reconfiguration to optimize the use of cube. After the initial analysis, twelve more SKUs were analyzed and similar changes projected an annual savings of \$1,102,736 (12.1%).

Advantage of Using a Packaging Consultant

The use of the outside consultant has provided a source of packaging expertise for Company "G" during a period when the need for cost reduction conflicted with limited available manpower to address cost reductions. Company "G" maintains an on-going relationship with the consultant to improve packaging of current products. New product packaging design conducted in-house also incorporates what has been learned from the current product packaging changes.

Some of the key points learned from the consultant include:

- **There is a definite need for Logistics involvement.**
- **The company must use a total cost perspective.**
- **All packaging variables should be considered including the primary packaging, shipping case, pallet pattern, re-arrangement, and packaging count.**
- **Slack should be reduced wherever possible.**
- **Environmental impact should be included in the overall analysis.**
- **Damage reduction can be an important consideration in total cost savings.**

BIBLIOGRAPHY

- "Major Changes in Materials Consumption: Emerging Trends in Use Patterns and New Materials," *The Franklin Report*, No. 37, October 14, 1991, p.1.
- "Message From: The Council for Solid Waste Solutions," Council for Solid Waste Solutions, Washington, D.C.
- "Multi-Material Recycling Manual," *The Keep America Beautiful System. Revised Edition.*, 1987.
- "Recycling Campaign Collects Companies," *USA Today*, September 16, 1992, p. 1.
- "Solid Waste: Dealing with the Final Stage of Production Distribution." Presentation. K. A. Eller, Associate Director, Environmental Coordinations, Proctor & Gamble and Kenneth R. Ernst, Partner, Anderson Consulting. Council of Logistics Management Annual Conference. September 30, 1991.
- "The Money in Europe's Muck." *The Economist*, November 20, 1993, pp. 81-82.
- "Why Waste a Second Chance? A Small Town Guide to Recycling.," *National Association of Towns and Townships*, Washington, DC., 1989.
- Amano, Hiromasa, "Environmental Protection at Tokyo Electric Power Company," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 32-37.

- Anonymous, "The 5th Annual Packaging 100," *Packaging*, July 1991, pp. 26-30.
- Anonymous, "The 6th Annual Packaging 100," *Packaging*, July 1992, pp. 24-30.
- Anonymous, "1992 Medal of Excellence," *Purchasing*, September 24, 1992, pp. 39.
- Anonymous, "Coke, Pepsi Help Boost Plastics Recycling Market," *Environment Today*, Volume 2, Issue 3, April 1991, p. 10.
- Anonymous, "DMA Writes Voluntary Recycling Plan," *Catalog Age*, Volume 9, Issue 10, October 1992, pp. 44.
- Anonymous, "EPA, GSA Move Full Speed Ahead to Promote Recycling," *Environment Today*, Volume 3, Issue 1, January/February 1992, pp. 19, 55.
- Anonymous, "Executive Insights" *Management Review*, Volume 79, Issue 11, November 1990, pp. 21-28.
- Anonymous, "Executives Debate Environment vs. Progress," *National Underwriter*, Volume 96, Issue 37, September 14, 1992, pp. 41-42.
- Anonymous, "Federated Copes with Recycling Situation," *Chain Store Age Executive*, Volume 67, Issue 4, April 1991, p. 72.
- Anonymous, "Follow a Leader to Recycle Mixed Paper," *Modern Office Technology*, Volume 36, Issue 9, September 1991, pp. 26.
- Anonymous, "How to Involve Employees in Solid Waste Reduction," *Environmental Manager*, Volume 3, Issue 4, November 1991, pp. 9-10, 16.
- Anonymous, "HP Goes Green: TQRDC + E," *Purchasing*, September 24, 1992, p. 39.

- Anonymous, "More Than an Ice Cream . . . Ben & Jerry's Is Social Responsibility," *Chain Store Age Executive*, Volume 67, Issue 8, August 1991, pp. 81, 83.
- Anonymous, "New Recycled Paper Standard Draws Ire of Environmentalists," *Environment Today*, Volume 3, Issue 2, March 1992, pp. 13.
- Anonymous, "Packaging Outlook: Availability at Good Prices," *Purchasing World*, Volume 34, Issue 4, April 1990, pp. 40-42.
- Anonymous, "Product Distributor Will Sell Them Only If They're 'Green,'" *Environment Today*, Volume 3, Issue 1, January/February 1992, pp. 28.
- Anonymous, "Rate Your Environmental Performance: A Corporate Checklist," *Environmental Manager*, Volume 3, Issue 4, November 1991, pp. 3-4, 16.
- Anonymous, "RCRA Reauthorization Debated," *NAPM Insights*, July 1992, pp. 26-27.
- Anonymous, "Recycler Reynolds Is Now Taking Back Aluminum Foil," *Environmental Manager*, Volume 3, Issue 3, October 1991, pp. 9-10.
- Anonymous, "Solid Waste: A Growing Concern for Retailers," *Chain Store Age Executive*, Volume 67, Issue 3, March 1991, pp. 16A-17A.
- Anonymous, "Top 100 1992," *Purchasing*, November 19, 1992, p. 49.
- Anonymous, "Why Pollution Prevention Pays at 3M," *Industrial Management*, Volume 11, Issue 4, May 1987, pp. 24-26.
- Appleton, Edward, "The Greenest of the Green," *Marketing*, March 28, 1991, pp. 22-23.

- Ashton, Robin; Erickson, Greg; Larson, Melissa "Reducing Solid Waste," *Packaging*, Volume 36, Issue 5, April 1991, pp. 24-32.
- Ashton, Robin, "Packaging Consumer Survey: Consumers Want It All," *Packaging*, June 1991, pp. 32-36.
- Ashton, Robin, "Consumers Want It All," *Packaging*, Volume 36, Issue 7, June 1991, pp. 32-36.
- Ashton, Robin, Greg Erickson, and Melissa Larson, "Reducing Solid Waste," *Packaging*, Volume 36, Issue 5, April 1991, pp. 24-32.
- Ashton, Robin, Greg Erickson, and Melissa Larson, "Packaging and the Solid Waste Problem," *Packaging*, Volume 34, Issue 11, August 1989, pp. 32-86.
- Ashton, Robin, Melissa Larson, Mark Spaulding, Lisa McTigue Pierce, Greg Erickson, and R. Bruce Holmgren, "Packaging Growth Will Slow in 1990," *Packaging*, Volume 34, Issue 16, December 1989, pp. 50-72.
- Auguston, Karen A., Nancy Staples, and Janine Weston, "Packaging in the '90s: The Environmental Impact," *Modern Materials Handling*, Volume 45, Issue 7, June 1990, pp. 52-57.
- Avery, Susan, "Buyers Master the Three Rs," *Purchasing*, Volume 111, Issue 8, November 21, 1991, pp. 98-99.
- Bailey, Jeff, "Major Venture For Recycling Loses a Partner," *The Wall Street Journal*, November 7, 1991.
- Baran, Josh, "Every Day Is Earth Day," *Public Relations Journal*, Volume 47, Issue 4, April 1991, pp. 22-23.
- Bard, Susan M., "Expanded Recycling Program to Include 159 Hyatt Hotels," *Hotel & Motel Management*, Volume 206, Issue 10, June 10, 1991, pp. 52, 26.

- Barnes, A. James, and Janice K. Ferry, "Creating a Niche for the Environment in the Business School Curriculum, *Business Horizons*, March-April 1992, p. 4.
- Barnes, Phillip E., "Business' Hottest Niche Market: The Environment," *Business & Economic Review*, Volume 37, Issue 3, April-June 1991, pp. 7-11.
- Barron, Tom, "Federal "Buy Recycled" Policy Finds Narrow Common Ground," *Environment Today*, Volume 3, Issue 5, June 1992, pp. 3, 25-26.
- Basta, Nicholas, "Plastics Recycling Gains Momentum," *Chemical Engineering*, Volume 97, Issue 11, November 1990, pp. 37-43.
- Basta, Nicholas and Eric Johnson, "Plastics Recycling Picks Up Momentum," *Chemical Engineering*, Volume 96, Issue 7, July 1989, pp. 30-33.
- Beaumont, John R., "Managing the Environment: Business Opportunity and Responsibility," *Futures*, Volume 24, Issue 3, April 1992, pp. 187-205.
- Bennett, Stephen, "Environmentalism Gets a Green Light," *Progressive Grocer*, Volume 70, Issue 1, January 1991, pp. 59-64.
- Bergstrom, Robin P., "Green Manufacturing: Fighting the Good Fight at Northrop," *Production*, Volume 103, Issue 11, November 1991, pp. 48-51.
- Berss, Marcia, "Turning Garbage into Gold," *Forbes*, Volume 148, Issue 9, October 21, 1991, pp. 142-144.
- Bertrand, Kate, "Government Boosts Market for Recycled Products," *Business Marketing*, Volume 75, Issue 11, November 1990, pp. 36.

Bertrand, Kate and Edmund O. Lawler, "Recycling, Yes. Buying Recyclables? Well . . .," *Business Marketing*, Volume 75, Issue 11, November 1990, pp. 30, 32.

Biddle, David, "Recycling for Profit: The New Green Business Frontier." *Harvard Business Review*, November-December 1993, pp. 145-156.

Bremner, Brian, "Recycling: The Newest Wrinkle in Waste Management's Bag," *Business Week*, Issue 3148, March 5, 1990, pp. 48-49.

Bridenbaugh, Peter R., "Needed: Partnerships Between Materials Producers, Customers, Customers' Customers," *Research-Technology Management*, Volume 34, Issue 3, May/June 1991, pp. 7-8.

Brimelow, Peter, and Leslie Spenser, "You Can't Get There From Here," *Forbes*, July 6, 1992, pp. 59-64.

Buzzelli, David T., "Time to Structure an Environmental Policy Strategy," *Journal of Business Strategy*, Volume 12, Issue 2, March/April 1991, pp. 17-20.

Cairncross, Frances, "How Europe's Companies Reposition to Recycle," *Harvard Business Review*, March-April 1992, pp. 34-45.

Calabro, Lori, "Changing Perceptions at Du Pont:: John J. Quindlen," *CFO: The Magazine for Chief Financial Officers*, Volume 7, Issue 1, January 1991, pp. 36-37.

Carson, Rachel, *Silent Spring*. Boston, Houghton Mifflin, 1962.

Casey, Eugene J., Jr., "A Plan for Environmental Packaging," *Journal of Business Strategy*, Volume 13, Issue 4, July/August 1992, pp. 18-20.

- Chandler, William U. "Converting Garbage to Gold: Recycling Our Materials," *Futurist*, Volume 18, February 1984, pp. 69-77.
- Chase, Dennis, "The Green Revolution: P&G Gets Top Marks in AA Survey," *Advertising Age*, Volume 62, Issue 5, January 29, 1991, pp. 8-10.
- Chynoweth, Emma, "Industry Focuses on Waste, Recycling, and Resources," *Chemical Week*, Volume 148, Issue 16, April 24, 1991, p. 21.
- Clark, Stephen E., "How to Survive in the Environmental Jungle," *Institutional Investor*, Volume 24, Issue 16, December 1990, pp. 89-91.
- Coalition of Northeastern Governors, *Final Report of the Source Reduction Task Force*. September, 1989, p. 13.
- Coddington, Walter, "It's No Fad: Environmentalism Is Now a Fact of Corporate Life," *Marketing News*, Volume 24, Issue 21, October 15, 1990, pp. 7.
- Coddington, Walter, "How to Green Up Your Marketing Mix," *Advertising Age*, Volume 61, Issue 36, September 3, 1990, pp. 30.
- Commoner, Barry *The Closing Circle: Nature, Man, and Technology*, New York, KNOFF, 1971.
- Correspondence with Planters LifeSavers Company in November 1991 as quoted in *Reverse Logistics*, a white paper prepared for the Council of Logistics Management by James R. Stock, p. 9.
- Cowen, Scott S. and Kendall J. Middaugh, II, "Matching an Organisation's Planning and Control System to Its Environment," *Journal of General Management*, Volume 16, Issue 1, Autumn 1990, pp. 69-84.

- Crabb, Stephen, "Has Industry Seen the Green Light?" *Personnel Management*, Volume 22, Issue 4, April 1990, pp. 42-47.
- Dagnoli, Judann, "Whose Job Is It to Define 'Green'?" *Advertising Age*, Volume 62, Issue 6, February 4, 1991, pp. 13.
- Darcey, Sue, "Congress Takes a Swing at the Recycling Logjam," *World Wastes*, Volume 35, Issue 4, April 1992, pp. 118b-118c, 121-124.
- Davis, Joel J., "A Blueprint for Green Marketing," *Journal of Business Strategy*, Volume 12, Issue 4, July/August 1991, pp. 14-17.
- Desai, Suzanne B., "Purchasing Ready to Help Solve Environmental Problems, Say Purchasers." *Midwest Purchasing Management*, October 1993', pp. 9-10.
- DiPietro, Robbe Charles, "State Procurement Programs Target Recyclables," *BioCycle*, Volume 32, Issue 10, October 1991, pp. 52-55.
- Doyle, J. Andrew, "1991 Regulations Update: Federal/State Issues Abound," *Modern Paint & Coatings*, Volume 81, Issue 4, April 1991, pp. 70-73.
- Duff, Charles, "Norsk Hydro's Environmental Report," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 23-31.
- Duff, Mike, "Springtime in Marketing: Will Supermarkets Find Gold in the 'Green' Issue? Loblaw's, Wal-Mart, and Others Are Betting They Can," *Supermarket Business*, Volume 45, Issue 4, April 1990, pp. 15-24, 45.
- E. Joseph Stilwell, R. Claire Canty, Peter W. Kopf and Anthony M. Montrone, *Packaging for the Environment: A Partnership for Progress*, New York: AMACOM, 1991.

- Economic Considerations in the Development of the National Packaging Protocol*. Canadian Council of Ministers of the Environment, May 1990.
- Edgett, Scott, and Des Thwaites, "The Influence of Environmental Change on the Marketing Practices of Building Societies," *European Journal of Marketing*, Volume 24, Issue 12 1990, pp. 35-47.
- Einsmann, Harald, "The Environment: An Entrepreneurial Approach," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 22-24.
- Eisenhart, Tom, "McRecycle USA: Golden Arches Offers Marketers a Golden Payoff," *Business Marketing*, Volume 75, Issue 11, November 1990, pp. 25, 28.
- Eisenhart, Tom, "There's Gold in That Garbage!" *Business Marketing*, Volume 75, Issue 11, November 1990, pp. 20-25.
- Erickson, Greg, "Milk in Bag Finds Niche; Saves \$," *Packaging*, Volume 33, Issue 7, May 1988, pp. 8-10.
- Erickson, Greg, "Packaging's 4th Annual Consumer Survey: Consumers Get Tough with Packaging," *Packaging*, Volume 33, Issue 8, June 1988, pp. 42-51.
- Erlich, Paul R., *The Population Bomb*. New York, Ballantine Books, 1968.
- Ettorre, John J., "Packaging Opening Up," *Transportation and Distribution*, Volume 28, Issue 13, December 1987, pp. 18-21.
- Evans-Correia, Kate, "Beating the Pulp out of Paper; Suppliers Claim Buyers Shortchange "Recycled,"" *Purchasing*, Volume 111, Issue 4, September 26, 1991, pp. 65-70.
- Evans-Correia, Kate, "Recycled Paper: Price Confusion," *Purchasing*, Volume 113, Issue 4, September 24, 1992, pp. 69, 71.

- Fahey, Alison, and Laurie Freeman, "Retailers Adding Touches of Green," *Advertising Age*, Volume 61, Issue 51, December 10, 1990, pp. 58.
- Fassett, Wayne S., "Higher Costs Don't Deter "Right Thing to Do"," *Bank Management*, Volume 67, Issue 8 August 1991, pp. 55.
- Fierman, Jaclyn, "The Big Muddle in Green Marketing," *Fortune*, Volume 123, Issue 11, June 3, 1991, pp. 91-101.
- Fisher, Christy, "Seal of Confusion: Competing Programs Bewilder Marketers," *Advertising Age*, Volume 62, Issue 26, June 24, 1991, p. 62.
- Fisher, Christy, "Tending Wal-Mart's Green Policy," *Advertising Age*, Volume 62, Issue 5, January 29, 1991, pp. 20, 22.
- Fisher, Christy and Judith Graham, "Wal-Mart Throws "Green" Gauntlet," *Advertising Age*, Volume 60, Issue 36, August 21, 1989, pp. 1, 66.
- Flesinger, E. G., "Dealing with Environmental Regulations and Agencies: An Industry Perspective," *Business Horizons*, March-April 1992, p. 41.
- Forrester, Jay W. *World Dynamics*. Wright-Allen Press, 1971.
- Franck, Irene and David Brownstone, *The Green Encyclopedia*, Prentice-Hall, 1992.
- Freeman, Virginia T. and Joseph L. Cavinato, "Fitting Purchasing to the Strategic Firm: Frameworks, Processes, and Values," *Journal of Purchasing and Materials Management*, Volume 26, Number 1, Winter 1990.
- Freeman, Laurie, "Lever, P&G Green Plans Differ," *Advertising Age*, Volume 61, Issue 30, July 23, 1990, p. 46.

- Freeman, Laurie, "Lever's Webb Seizes Green Issues," *Advertising Age*, Volume 61, Issue 35, August 27, 1990, pp. 3, 35.
- Freeman, Laurie, "The Green Revolution: Procter & Gamble," *Advertising Age*, Volume 62, Issue 5, January 29, 1991, pp. 16, 34.
- Freeman, Laurie, "The "Greening" of America II," *Advertising Age*, Volume 60, Issue 49, November 13, 1989, p. S14.
- Frosch, Robert A. and Nicholas E. Gallopoulos, "Strategies for Manufacturing." *Scientific American*, Volume 261 n3, September 1989, pp. 144-52.
- Fusco, Mary Ann Castronovo, "Employment Relations Programs," *Employment Relations Today* Volume 17, Issue 4, Winter 1990-1991, pp. 333-335.
- Gilges, Kent, "Eco-Audit: Green Eyeshades Take On a Whole New Meaning," *Chemical Engineering*, Volume 98, Issue 5, May 1991, pp. 82N-82V.
- Gillespie, Robert J., "Pitfalls and Opportunities for Environmental Marketers," *Journal of Business Strategy*, Volume 13, Issue 4, July/August 1992, pp. 14-17.
- Gilman, Alan L., "Managing Environmental Liabilities," *Chain Store Age Executive*, Volume 68, Issue 2, February 1992, pp. 79.
- Gold, Jackey, " The Pioneers: 3M and H.B. Fuller Have Taken the Lead in Learning How to Make Pollution Control Equal Cost Control," *Financial World*, Volume 159, Issue 2, January 23, 1990, pp. 56-58.
- Goldberg, Daniel, "Cost Avoidance Makes Recycling Pay," *Transportation & Distribution*, Volume 30, Issue 10, October 1989, pp. 52-54.

- Goldoftas, Barbara, "Recycling: Coming of Age," *Technology Review*, Volume 90, Issue 8, November/December 1987, pp. 28-35, 71.
- Goldstein, Gina, "Rechanneling the Waste Stream," *Mechanical Engineering*, Volume 111, Issue 8, August 1989, pp. 44-50.
- Gordon, Jeffrey J., "Recirculation as a Form of Conservation.," *Transition*, Volume 12 n2, 1982, pp. 2-7.
- Graves, Michael E., "The Greening of Business Documents: An Environmental Strategy for Micrographics," *IMC Journal*, Volume 28, Issue 4, July/August 1992, pp. 6-9.
- Greenberger, Leonard S., "State Legislatures Rank 1991 Priorities," *Public Utilities Fortnightly*, Volume 127, Issue 5, March 1, 1991, pp. 37-38.
- Greeno, J. Ladd, "Good Environmental Management Can Sharpen Competitive Strategies," *Environment Today*, Volume 2, Issue 6, July/August 1991, pp. 49.
- Grossman, Laurie M., "Florida to Buy Back Its Recycles Waste," *The Wall Street Journal*, June 19, 1992.
- Guiltinan, Joseph P., and Nonyelu G. Nwokoye, "Developing Distribution Channels and Systems in the Emerging Recycling Industries," *International Journal of Physical Distribution*, Volume 6, Number 1, 1975, pp. 28-38.
- Haiss, Peter R., "The Twin Challenges to Austrian Banking: the Environment and the East," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 47-53.
- Hanneman, Rodney, Jean-Pierre Ergas, Robert Weis, and Darrell Morrow, "Aluminum, Plastics Recycling Speeches Found an Audience in 1990," *Beverage World*, Volume 110, Issue 1483, January 31, 1991, p. 5.

- Hanson, Donald W., "New Challenges for Packaging in the 90s," *Drug and Cosmetic Industry*, Volume 148, Issue 2, February 1991, pp. 26-32.
- Heard, Frank M., "What Executives Don't Know About Environmental Strategy," *Public Utilities Fortnightly*, Volume 129, Issue 3, February 1, 1992, pp. 17-20.
- Hedzik, Kimberly, "A Bundle of Packaging Alternatives," *NAPM Insights*, July 1992, pp. 22-23.
- Hemphill, Thomas A., "A Solid Program for Solid Waste?" *Business & Society Review*, Issue 75, Fall 1990, pp. 67-71.
- Hemphill, Thomas A., "Marketer's New Motto: It's Keen to Be Green," *Business & Society Review*, Issue 78, Summer 1991, pp. 39-44.
- Herbst, Thomas., Ohio Waste Paper Division, Grossman Industries, Inc., Personal Interview, April 9, 1992.
- Hirschhorn, Joel S., "Cutting Production of Hazardous Waste," *Technology Review*, Volume 91, Issue 3, April 1988, pp. 52-61.
- Household Consumers and Packaging: An Overview of Current Trends, Initiatives and Implications for the National Packaging Protocol*, Canadian Council of Ministers of the Environment, May 1990.
- Hunt, Christopher B. and Ellen R. Auster, "Proactive Environmental Management: Avoiding the Toxic Trap," *Sloan Management Review*, Volume 31, Issue 2, Winter 1990, pp. 7-18.
- Hutchinson, Colin, "Corporate Strategy and the Environment," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 9-21.
- Hutchinson, Colin, "Environmental Issues: The Challenge for the Chief Executive," *Long Range Planning*, Volume 25, Issue 3, June 1992, pp. 50-59.

Information from documentation accompanying PackTrack™ software received from Mr. Randolph T. Haviland, Johnson & Johnson Company.

Introduction to Survey Sampling. Graham Kalton, Sage Publications, 9th Edition, 1990.

Jacob, Rahul, "Body Shop International: What Selling Will Be Like in the '90s," *Fortune*, Volume 125, Issue 1, January 13, 1992, pp. 63-64.

Jaquette, Leslee, "Canadian Pacific Gets Specific with "Green" Plan," *Hotel & Motel Management*, Volume 206, Issue 14, August 19, 1991, pp. 65, 68.

Jaquette, Leslee, "Canadian Pacific Hotels Creates "Green Plan"," *Hotel & Motel Management*, Volume 206, Issue 2, February 4, 1991, pp. 54, 58.

Jaquette, Leslee, "Westin Shapes "Green" Goals," *Hotel & Motel Management*, Volume 206, Issue 19, November 4, 1991, pp. A-49, A-51-A-52.

Johnson, Samuel E., "Facility Managers: Their Stature Grows," *Office*, Volume 115, Issue 1, January 1992, pp. 37.

Kamlet, Kenneth S., "Ten Commandments for Environmental Managers," *Environment Today*, Volume 2, Issue 1, January/February 1991, pp. 44-62.

Keegan, Daniel P., Charles R. Jones, and Robert G. Eiler, "To Implement Your Strategies, Change Your Measurements," *Price Waterhouse Review*, Volume 35, Issue 1, 1991, pp. 29-38.

Kiesche, Elizabeth S., "Recycling: A Delicate Success Formula," *Chemical Week*, Volume 147, Issue 25, December 19/December 26, 1990, pp. 42-46.

- Kirkpatrick, David, "Environmentalism: The New Crusade," *Fortune*, Volume 121, Issue 4, February 12, 1990, pp. 44-55.
- Klein, Easy, "The Selling of the Green," *D&B Reports*, Volume 38, Issue 5, September/October 1990, pp. 30-31, 35.
- Kleiner, Art, "What Does It Mean to Be Green?" *Harvard Business Review*, July-August 1991, pp. 38-47.
- Koselka, Rita, "Casey at the Bottling Plant," *Forbes*, Volume 146, Issue 3, August 6, 1990, pp. 88-89.
- Kovacks, W.L., Presentation sponsored by Canadian Institute for Environmental Law and Policy. on "Getting Serious About Waste Reduction," December 5, 1989 as cited in *Legislative Initiatives Relating to Packaging and Implications for the National Packaging Protocol*, Canadian Council of Ministers of the Environment, May 1990.
- Lallande, Ann, "Environmental Marketing: The Next Wave," *Marketing & Media Decisions*, Volume 23, Issue 12, December 1988, pp. 174, 176.
- Landegger, Carl C., "The True Cost of Recycling," *Chief Executive*, Issue 68, June 1991, pp. 34-37.
- Langrehr, Virginia B., Frederick W. Langrehr, and John Tatreau, "Business Uses' Attitudes Toward Recycled Materials," *Industrial Marketing Management*, Volume 21, 1992. pp. 361-367.
- Larson, Melissa, "Analyzing Solid Waste," *Packaging*, Volume 34, Issue 11, August 1989, pp. 8-10.
- Larson, Melissa, "Consumers Determine Package Success," *Packaging*, Volume 35, Issue 7, June 1990, pp. 38-42.
- Lawrence, Jennifer, "Marketers Drop "Recycled"," *Advertising Age*, Volume 63, Issue 10, March 9, 1992, pp. 1, 48.

- Legislative Initiatives Relating to Packaging and Implications for the National Packaging Protocol*, Canadian Council of Ministers of the Environment, May 1990.
- Levin, Gary, "Consumers Turning Green: JWT Survey," *Advertising Age*, Volume 61, Issue 47, November 12, 1990, p. 74.
- Lodge, George C., and Jeffrey F. Rayport, "Knee-Deep and Rising: America's Recycling Crisis," *Harvard Business Review*, September-October 1991, pp. 128-139.
- Losey, Michael R., "Recycling Is the Smart Thing to Do," *Modern Office Technology*, Volume 36, Issue 5, May 1991, pp. 100, 102.
- Lumsdon, Kevin, "Purchasing: Hospitals Weigh Environment Factor," *Hospitals*, Volume 66, Issue 2, January 20, 1992, pp. 62, 64.
- MacDonald, Ann, "How Effective Are Federal Procurement Policies?" *BioCycle*, Volume 32, Issue 9, September 1991 pp. 47-49.
- Marshall, M. E. and David W. Mayer, "Environmental Training: It's Good Business," *Business Horizons*, March-April 1992, p. 54.
- McCaughey, Lorraine, "New Instruments for Navigating the Nineties," *Canadian Business Review*, Volume 18, Issue 4, Winter 1991, pp. 40-42.
- McManus, James R. and James J. Carter, "Green Marketing," *Chief Executive*, Issue 64, January/February 1991 pp. 26-29.
- McQuiston, Daniel H., "The Relative Participation of Functional Roles in the Industrial Decision Making Unit." unpublished dissertation, The Ohio State University, 1985.
- Meadows, Donella H. [and others], Massachusetts Institute of Technology *The Limits to Growth*. New York, Universe Books, 1972.

- Meltzer, Susan R., "Corporate Risk Management: A Canadian Perspective," *Canadian Insurance*, Volume 97, Issue 6, 1992, pp. 44-48.
- Miller, Cyndee, "Cosmetics Industry's Marketing Approach Says 'Color Me Green,'" *Marketing News*, Volume 25, Issue 12, June 10, 1991, p. 2.
- Monczka, Robert M. and Robert J. Trent, *International Journal of Purchasing and Materials Management*, Fall 1992, pp. 9-19.
- Monczka, Robert M. and James P. Morgan, "Letter to the CEO. Part 1: Strategic Sourcing Management," *Purchasing*, June 18, 1992, pp. 52-55.
- Monczka, Robert M. and James P. Morgan, "Letter to the CEO. Part 2: Strategic Sourcing Management," *Purchasing*, July 16, 1992, pp. 64-67.
- Morgan, James P., "Purchasing 2000: Strategic Sourcing Rises to the Top," *Purchasing*, April 2, 1992, pp. 54-58.
- Mori, Tetsuro, "Environment: How Computer Trio Manages Clean Operation," *Tokyo Business Today*, Volume 60, Issue 6, June 1992, pp. 44-47.
- Morris, Gregory D., Elizabeth S. Kiesche, David Rotman, Andrew Wood, and Faye Flam, "Filling New Needs in Packaging," *Chemical Week*, Volume 147, Issue 3, July 25, 1990, pp. 26-34.
- Mosberg, Stewart, "Educating Consumers About 'Green' Packaging," *Progressive Grocer*, Volume 70, Issue 1, January 1991, pp. 64, 66.
- Moskowitz, Marcie, "Solid Waste Council Targets 25%-Bottle Recycle Rate," *Plastics World*, Volume 49, Issue 5, April 1991, pp. 58-60.
- Muller, E. J., "The Greening of Logistics," *Distribution*, Volume 90, Issue 1, January 1991, pp. 26-34.

- Murphy, Paul R., and Richard F. Poist, "Management of Logistical Retromovements: An Empirical Analysis of Literature Suggestions," *Transportation Research Forum*, 1989, pp. 177-184.
- Nash, Tom, "Green About the Environment?" *Director*, Volume 43, Issue 7, February 1990, pp. 40-44 .
- National Solid Waste Management Association, October 1990, as reported in *Solid Waste Management in Florida, 1990 Annual Report*, Florida Department of Environmental Regulation, March 1991, p. 5.
- Neal, Mollie, "Marketers Develop a New Climate," *Direct Marketing*, Volume 54, Issue 10, February 1992, pp. 26-27, 79.
- Newall, J. E., "Managing Environmental Responsibility," *Business Quarterly*, Volume 55, Issue 2, Autumn 1990, pp. 90-94.
- Nieder, Norman, "Anheuser-Busch and the Environment," *Beverage World*, Volume 110, Issue 1484, February 1991, pp. 42-43.
- Nulty, Peter, "Recycling Becomes a Big Business," *Fortune*, Volume 122, Issue 4, August 13, 1990, pp. 81-86.
- Nussbaum, Bruce, and John Templeman, "Built to Last-Until It's Time to Take It Apart," *Business Week (Industrial/Technology Edition)* Issue 3178, September 17, 1990, pp. 102-106.
- Olson, Robert L. "The Greening of High Tech," *Futurist*, Volume 25, Issue 3, May/June 1991, pp. 8-34.
- Packaging, Reduction, Reuse and Recycling Technology Options*, Canadian Council of Ministers of the Environment, May 1990.
- Packaging Application in Canada*, Canadian Council of Ministers of the Environment, May 1990.

Pels, Mary Ann, "Lean, Mean, and Green," *Credit Union Magazine*, Volume 57, Issue 6, June 1991, pp. 63-64.

Penzer, Erika, "Turning "Green"," *Incentive*, Volume 164, Issue 7, July 1990, pp. 26-28, 128.

Personal interview with Edwin Caywood, President of CPI-Rincon Valley Sanitation, Rincon Valley, Arizona on January 12, 1993.

Peters, George, personal interview, Education and Research Manager, Division of Litter Prevention and Recycling, Ohio Department of Natural Resources, May 3, 1991.

Picarille, Lisa and Coale, Kristi "Developers Address Environmental Issues," *InfoWorld*, Volume 13, Issue 14, April 8, 1991, p. 42.

Pohlen, Terrance L. and M. Theodore Farris II, "Reverse Logistics in Plastics Recycling," *International Journal of Physical Distribution and Logistics Management*, Volume 22, Number 7, 1992 pp. 42-45.

Pollock, Cynthia, "There's Gold in Garbage," *Across the Board*, Volume 24, Issue 3, March 1987, pp. 28-38.

Pond, James S., "Recycling in America: Business Cleans Up Its Act," *Today's Office* Volume 25, Issue 10, March 1991, pp. 33-46.

Porter, J. Winston, and Jonathan Z. Cannon, "Waste Minimization: Challenge for American Industry," *Business Horizons*, March-April 1992, p.48.

Prince, Greg, "New Tricks," *Beverage World*, Volume 110, Issue 1492, June 1991, pp. 42, 44.

Public Attitudes Toward Recycled Paper Packaging, The Gallup Organization, Inc. for the American Paper Institute, January 20, 1989.

- Rademaker, Ken, "Going, Going, Green," *Occupational Hazards*, Volume 53, Issue 9, September 1991, pp. 121-123.
- Rathje, William L. and Cullen Murphy, *Rubbish*. Harper Collins Books, 1992.
- Rathje, William L., "The History of Garbage," *Garbage*, July 1992, pp. 32-41.
- Reaching for Solutions*. Toronto, Ontario, Canada: The Packaging Association of Canada, 1991, p. 11.
- Reck, Robert F. and Brian G. Long, "Purchasing: A Competitive Weapon," *Journal of Purchasing and Materials Management*, Volume 24, Number 3, Fall 1988.
- Redmond, Steve, "Greens Roll On After Ozone Win," *Marketing*, July 28, 1988, p. 15.
- Reducing Reliance on Landfills: Solid Waste Management Plan Highlights*. Franklin County Regional Solid Waste Management Authority, February 1992.
- Reichard, Robert S., Risk Management: A Purchasing Tool for the 21st Century," *Purchasing*, May 21, 1992, pp. 40-45.
- Reichard, Robert S., "Purchasing 2000: Risk Management: A Purchasing Tool for the 21st Century," *Purchasing*, May 21, 1992, pp. 40-45.
- Reverse Logistics*, a white paper prepared for the Council of Logistics Management by James R. Stock.
- Rogers, James E., "Adopting and Implementing a Corporate Environmental Charter," *Business Horizons*, March-April 1992, p. 29.

- Rogers, Jack K., "Molders of HDPE HIC Bottles Have a Big Stake in Recycling," *Modern Plastics*, Volume 67, Issue 1, January 1990, pp. 47-49.
- Rosendahl, Iris, "Environmental Claims Abound as Hunt for Guidelines Goes On," *Drug Topics*, Volume 135, Issue 6, March 25, 1991, pp. 59-60.
- Roy, R. Whelan, "Successful Recycling Through Value-Chain Collaboration," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 62-71.
- Rublin, Lauren R., "Wellman Inc.: It Mines Profits from Discarded Plastic Soda Bottles," *Barron's*, Volume 68, Issue 26, June 27, 1988, pp. 63-64.
- Salzhauer, Amy Lynn, "Obstacles and Opportunities for a Consumer Ecolabel," *Environment*, Volume 33, Number 9, November 1991, pp. 10-37.
- Savage, J. A., "Vendors Step Up Recycling Efforts," *Computerworld*, Volume 25, Issue 26, July 1, 1991, pp. 1-62.
- Scerbinski, Jacqueline S., "Consumers and the Environment: A Focus on Five Products," *Journal of Business Strategy*, Volume 12, Issue 5, September/October 1991 pp. 44-47.
- Schaffer, Daniel, "Exploring Environmental Frontiers: Integrating Solutions East and West," *Survey of Business*, Volume 26, Issue 4, Spring 1991, pp. 5-27.
- Schlossberg, Howard, "Ameritech Plans Major Product, Service Expansion," *Marketing News*, Volume 25, Issue 14, July 8, 1991, pp. 1, 12.
- Schlossberg, Howard, "Green Marketing Has Been Planted-Now Watch It Grow," *Marketing News*, Volume 25, Issue 5, March 4, 1991 pp. 26, 30.

- Schlossberg, Howard, "Solid Waste Issue Overshadowed by Global Warming," *Marketing News*, Volume 26, Issue 15, July 20, 1992, pp. 13.
- Schouest, Kim, "Up in Smoke," *Beverage World*, Volume 110, Issue 1494, July 1991, pp. 60-61.
- Shaw, Russell, "A Lot of Rubbish," *Restaurant Hospitality*, Volume 74, Issue 3, March 1990, pp. 142-148.
- Sheate, W. R., "Lobbying for Effective Environmental Assessment," *Long Range Planning*, Volume 25, Issue 4, August 1992, pp. 90-98.
- Sheehan, Christopher J., "Two Avenues of Growth for the Paper Industry," *Office*, Volume 114, Issue 5, November 1991, pp. 56, 63.
- Simms, Christine, "Green Issues and Strategic Management in the Grocery Retail Sector," *International Journal of Retail & Distribution Management*, Volume 20, Issue 1, January/February 1992, pp. 32-42.
- Smith, Emily T., "Cleaning Up on the Coming Cleanup," *Business Week (Industrial/Technology Edition)*, Issue 3128, October 16, 1989, pp. 98, 102.
- Snodgrass, Tod, "Ideal Overhead: Lean and Mean," *Credit Union Management*, Volume 14, Issue 4, April 1991, pp. 44-45.
- Socha, Wayne J. and Sally E. Harvey, "Mini-Green Audits," *Internal Auditor*, Volume 48, Issue 5, October 1991, pp. 38-43.
- Solid Waste Disposal Overview*, Washington, DC: National Solid Waste Management Association, 1991, p. 2.
- Sparkman, David L., "Trucking Has a Major Role in Controlling Solid Waste," *Transport Topics*, November 11, 1991, p. 6.

- Spencer, David, "Waste Solutions: Dimensions," *Modern Plastics Supplement*, April 1990, pp. 9-20.
- Stack, E. Gifford, "Recycling Presence Intensifies at WasteExpo 1991," *Beverage World*, Volume 110, Issue 1490, May 1991, pp. 78-79.
- Statistical Record of the Environment*. Compiled and edited by Arsen J. Damay, Gale Research, Inc. 1992.
- Steger, Ulrich, "Corporations Capitalize on Environmentalism," *Business & Society Review*, Issue 75, Fall 1990, pp. 72-73.
- Steuteville, Robert, "State Market Initiatives: Economic Development in the Recycling Arena," *BioCycle*, Volume 33, Issue 8, August 1992, pp. 40-44.
- Stone, Robert F., Ambuj D. Sagar, and Nicholas A. Ashford, "Recycling the Plastic Package," *Technology Review*, July 1992, pp. 49-56.
- Strom, Janine, "IS Soldiers Fight the Green War," *Canadian Datasystems*, Volume 24, Issue 5, May 1992, pp. 38-40.
- Stuart, Gregory, "Environment Moves Up Packaging Agenda," *Marketing*, August 20, 1992, pp. 18-19.
- Stuller, Jay, "The Politics of Packaging," *Across the Board*, Volume 27, Issue 1,2, January/February 1990, pp. 40-48.
- Stundza, Tom, "Recycling Resources: New Raw Material Sources for the '90s," *Purchasing*, Volume 109, Issue 7, November 8, 1990, pp. 64B26-64B28.
- Stundza, Tom, "Treat Scrap as Trash and You Throw Money Away," *Purchasing*, Volume 111, Issue 1, July 18, 1991, pp. 66-69.
- Stundza, Tom, "You and the Environment," *Purchasing*, Volume 112, Issue 7, April 16, 1992, pp. 49-53.

Sudol, Frank, "A "Buy Recycled" Program That Works," *American City & County*, Volume 107, Issue 9, August 1992, pp. 18.

Sutton, John R., "Smart Industry Decisions Can Produce Growth Amid Growing Regulations," *Industrial Engineering*, Volume 24, Issue 3, March 1992, pp. 14-15.

Testin, Robert F. and Peter J. Vergano, "Food Packaging," *Food Review*, Volume 14, Issue 2, April-June 1991, pp. 31-33.

Teufel, Robert J., "Are Marketers Turning Green?" *Direct Marketing*, Volume 53, Issue 1, February 1991, pp. 27-30.

The Canadian Green Marketing Handbook, Southam Business Communications, pp. 79-119.

Torok, Douglas B., "Returnable Containers for JIT Handling," *Material Handling Engineering*, Volume 44, Issue 11, November 1989, pp. 48-51.

Treistman, Joan, "Package Design Left Out of Green Revolution," *Marketing News*, Volume 25, Issue 25, December 9, 1991, pp. 4-5.

Trunick, Perry A., "Take Action on the Environment," *Transportation & Distribution*, Volume 33, Issue 5, May 1992, pp. 60-64.

Twede, Diana, "Take Out the Trash: Strategies to Reduce Your Customer's Packaging Waste." *RPS newsPAK*, Volume 4, Issue 3, Fall 1993, pp. 8-11.

Twedt, Nachele, Account Representative, Ohio Waste Paper Division, Grossman Industries, Inc., Personal Interview, March 5, 1992.

- U.S. Bureau of Census, *Annual Survey of Manufacturers*, (Washington, D.C.: U.S. Government Printing Office, 1985) General Statistics for Industry Groups, p. 8 and appendix; and J. Miller and A. Roth, *Report on the 1986 North American Manufacturing Futures Survey*, (Boston: Boston University, 1986).
- U.S. Environmental Protection Agency, *Markets Study*, 1989, p. 8.
- Vandermerwe, Sandra; and Micheal D. Oliff, "Customers Drive Corporations Green," *Long Range Planning*, Volume 23, Issue 6, December 1990, pp: 10-16.
- Vandermerwe, Sandra and Michael D. Oliff, "Corporate Challenges for an Age of Reconsumption," *Columbia Journal of World Business*, Volume 26, Issue 3, Fall 1991, pp. 6-25.
- Vandermerwe, Sandra and Micheal D. Oliff, "Customers Drive Corporations Green," *Long Range Planning*, Volume 23, Issue 6, December 1990, pp. 10-16.
- Vandervoort, Susan Schaefer, "Big "Green Brother" Is Watching," *Public Relations Journal*, Volume 47, Issue 4, April 1991, pp. 14-19, 26.
- Vasilash, Gary S., "Materials: A Glance Back & Forth and Beyond," *Production*, Volume 102, Issue 5, May 1990, pp. 72-73.
- Voss, Bristol, "The Green Marketplace," *Sales & Marketing Management*, Volume 143, Issue 8, July 1991, pp. 74-76.
- Waste Reduction Guide for Ohio's Business and Industry*. Ohio Department of Natural Resources, Division of Litter Prevention and Recycling, 1991.
- Watson, Tom, "Singapore: Recycling in at Southeast Asia City State," *Resource Recycling*, Volume 6, Number 7, pp. 102-105.

- Watts, Charles A., Kim, Kee Young, and Chan K, Hahn, "Linking Purchasing to Corporate Competitive Strategy," *International Journal of Purchasing and Materials Management*, Fall 1992, p.3.
- Webb, Nan, " Recycling Tasks Are Part of the Job," *Purchasing World*, Volume 35 Issue 3, March 1991, pp. 42-43
- Weiner, Edith and David Closs, "Formulas for the Future; Best Bets for the Jet Set," *World*, Volume 25, Issue 3, 1991 pp. 2-4.
- Wiechmann, Kristin S., "Survival of the Fittest: U.S. Multinationals Get Set for EC Reforms," *Pennsylvania CPA Journal*, Volume 63, Issue 1, Summer 1992, pp. 8-10.
- Wilsher, Peter, "The Feeling Grows That Going Green Is Good for Business," *Management Today*, October 1991, pp. 27, 30.
- Winters, Patricia, "Green Marketing: Cola Giants Take Packaging Lead," *Advertising Age*, Volume 61, Issue 52, December 17, 1990, p. 30.
- Witt, Clyde E., "Packaging: From the Plant Floor to the Global Customer," *Materials Handling Engineer*, October 1992, pp. 39-77.
- Yang, Dori Jones, "Recycling Is Rewriting the Rules of Papermaking," *Business Week*, Issue 3210, April 22, 1991, pp. 100H, L.