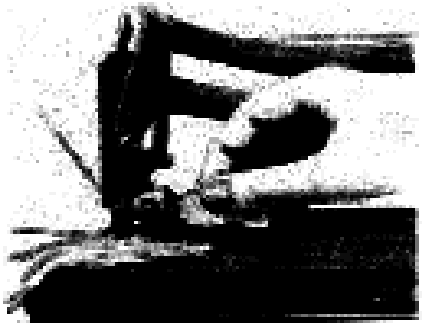
To Riches From Rags: Profiting From Waste Reduction



A Best-Practices Guide for Textile and Apparel Manufacturers

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By

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Cardstock Cover Contains 20% Recycled Fiber: 70% Post-Consumer Content
Text Printed on 100% Recycled Paper: 25% Cotton Fiber Content

NOTICE

This report was prepared by the Textile Development and Marketing Department of the Fashion Institute of Technology and the Long Island City Business Development Corporation (LICBDC) Industrial Waste Recycling and Prevention (INWRAP) Program in the course of performing work contracted for and sponsored by the United States Environmental Protection Agency Region 2 (hereafter the EPA). The EPA under Solid Waste Management Assistance Grant X-1992947-98-0 to LICBDC has funded this document wholly or in part. The opinions expressed in this report do not necessarily reflect those of the EPA; and any reference to specific products, services, processes, or methods does not constitute an implied or expressed recommendation or endorsement of it.

About the U.S. EPA Region 2 Office of Solid Waste

The Office of Solid Waste (OSW) operates under authority of the Resource Conservation and Recovery Act. It protects human health and the environment by ensuring responsible national management of hazardous and non-hazardous waste.

Its goals are:

- To conserve resources by reducing waste
- To prevent future waste disposal problems by writing result-oriented regulations
- To clean up areas where waste may have spilled, leaked, or been improperly disposed of

Individual states adopt federal standards and operate their own waste management programs. Besides states, OSW works closely with industry, environmental groups, tribes, and the concerned public to promote safe waste management.

These shared responsibilities help to:

- Set national environmental goals, policies, and priorities
- Assume leadership roles in environmental education
- Write flexible, health-based regulations that reflect ecological risks and environmental justice

EPA works to assure the safe management of non-hazardous household, industrial, and mining wastes. Because everyone shares responsibility for reducing and managing these wastes, OSW policies rely heavily on national voluntary and educational programs. It promotes and encourages the use of combined methods to manage solid waste. These methods are: source-reduction or waste prevention, which means any practice that reduces the amount or toxicity of waste generated; and recycling, which conserves disposal capacity and preserves natural resources by preventing potentially useful materials from being disposed of by either landfilling or waste combustion. (Source: EPA website: www.epa.gov/epaoswer/osw.html)

ACKNOWLEDGEMENTS

Peer Review

The development of this guide was made possible by the generous contribution of time, information, experience and resources from many individuals.

We would like to acknowledge the important role of Dr. Fred Golden of FIT, whose previous work on textile and fabric waste reduction and recycling provided the framework for our research and development of this document.

We are grateful to the staff of LICBDC for performing the initial review of this document. We also wish to acknowledge the contributions of Edgar Bello, formerly of the Hofstra University Industrial Assessment Center (IAC) and Rich Malachowski from Cranston Printworks Company. In addition, we would like to thank MaryEllen Etienne and Nicole Egger of NY Wa$teMatch for the final editing, layout and design services for this guide.

Finally, we are extremely grateful to the U.S. Environmental Protection Agency (EPA) for supporting this project. We extend a special thank you to Ms. Lorraine Graves of the U.S. EPA Region 2, who has provided advice and assistance in her capacity as project officer and coordinator of the Wa$teWise program.

Project Development and Coordination

This project involved a collaboration between the LICBDC Industrial Waste Recycling and Prevention (INWRAP) Program and the Textile Development and Marketing Department at the Fashion Institute of Technology (FIT). The individuals principally responsible for managing this project for each organization were:

- John Okun, Director of the Industrial Waste Recycling and Prevention (INWRAP) Program at LICBDC
- Professor George Ganiaris, Chairperson of the Textile Development and Marketing Department at FIT

Day-to-day responsibility for coordinating the project was handled by the staff of LICBDC's INWRAP Program with assistance from the FIT Textile and Marketing Department faculty on an as-needed basis. The best practices guide, "To Riches From Rags: Profiting From Waste Reduction, A Best-Practices Guide for Textile & Apparel Manufacturers," was primarily written and developed by Professor George Ganiaris with assistance from John Okun.

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SUMMARY

The purpose of this project is to develop and provide state-of-the-art waste reduction resources and practices for textile and apparel industry firms located in EPA Region 2. The targeted audience consists of textile dyers, finishers, apparel producers (woven/knit), cut-and-sew operations, textile bleachers, textile recyclers, and textile printers. Leading manufacturing, environmental management compliance, and energy and research experts from the textile and apparel industries were invited to contribute. This guide will help educate representatives from industry in the following areas of interest:

- Methods to Decrease Chemical Wastes
- Efficient Source-reduction and Recycling Techniques
- Raw Material Control Strategies
- Reuse Opportunities
- Successful Case Examples
- Chemical Alternatives: Safety and Cost Savings
- Energy Cost-Saving Practices
- Sources of Technical Assistance

The project's development team, consisting of the FIT Textile Development and Marketing Department and the LICBDC INWRAP Program with the assistance of the Cyntex Company, hosted a day-long conference on waste prevention and recycling strategies for textile and apparel manufacturers on March 16, 2000.

Thirty-two representatives from industry and technical assistance organizations attended the "To Riches From Rags" conference. There was a series of outstanding presentations, and several firms made valuable contacts. In addition, a video of the conference was produced along with a written compilation of the conference proceedings.

SECTION 1

INTRODUCTION

Background

There are more than 6,000 textile manufacturing and apparel production companies located in the metropolitan New York and New Jersey area. Within New York City alone there are 84,000 workers officially employed by 4,000 apparel and knitwear manufacturers.[1]

According to a City of New York commercial waste composition study, apparel firms and textile manufacturers generate approximately 384,000 tons of waste each year.[2] Much of this is recyclable, a fact codified in New York City's 1993 commercial recycling ordinance, Local Law 87. Under this law, any company generating more than 10% of its waste as textile scrap must recycle that material along with the other mandated commercial recyclables (paper, cardboard, etc.).

For companies required to recycle their textile waste, the greatest difficulty comes when they have small quantities of different colors and types of fabric. Most recyclers want fabrics and colors collected separately. In facilities with limited space, this makes cost-effective recycling of textiles difficult to achieve.

Waste prevention is an obvious solution to this problem. The American Textile Manufacturers Institute's recent survey of 36 companies and 260 plants showed that after implementing waste reduction practices the total amount of waste generated per plant per month decreased by 44%.[3] Although several apparel firms have both reduced the quantity of material they use in production and the amount they ultimately discard by refining their layout and fabric cutting techniques, there are still many more firms which have yet to implement these practices.

Advances in computer-aided design have helped companies lower their costs, as has the use of continuous-feed systems which reduce the amount of material used and the number of partially finished apparel discarded by textile fabricators. Other reuse strategies, such as targeting the recovery of yarn cones, plastic fabric and yarn shipping bags, and corrugated cardboard containers, have been implemented in several apparel and textile manufacturing facilities.

At knitting and textile dyeing facilities there is an additional set of environmental regulations which must be followed. Many of the dyeing and finishing practices used by these firms generate hazardous waste or emit volatile organic compounds. At several textile manufacturing facilities in the southern United States, process modifications have been implemented which eliminate the use of many of these toxic compounds saving companies thousands of dollars in disposal and safety compliance costs each year. Other pollution prevention process changes have resulted in reductions in energy and water consumption.

For example, Ti-Caro, a North Carolina textile manufacturer that produces dyed and finished fabrics, implemented several process modifications and chemical substitutions to reduce its effluent discharge levels.[4] These pollution prevention applications not only brought the firm into compliance and reduced its water usage, but resulted in over $15,000 per year in savings. Americal Corp., a nylon hose producer, is realizing $35,000 per year in savings by applying similar pollution-prevention strategies to its dyeing and discharge and wastewater treatment processes.[5]

As noted earlier, the FIT Textile Development and Marketing Department, in conjunction with the LICBDC INWRAP Program and the Cyntex Corporation developed and hosted a regional waste prevention and recycling conference for textile manufacturing and apparel production firms. The conference, featuring speakers from the FIT faculty, government agencies, business operators, and the consultant community, was held at the Fashion Institute of Technology on March 16, 2000.

The conference provided information on:

- Pollution prevention, solid waste reduction and recycling strategies successfully implemented by textile and apparel manufacturers
- Environmental regulations affecting textile dyeing and finishing operations
- Strategies to eliminate or conserve chemical use at finishing shops and other manufacturing operations
- Strategies to decrease fabric waste through changes in technology and operations
- Textile recycling trends and opportunities in the region
- Non-textile recycling and reuse opportunities at apparel and textile manufacturing facilities
- Pollution prevention and solid waste technical assistance resources available to local businesses
- Means to identify waste prevention and reuse opportunities for waste materials
- Methods for cutting trash-hauling costs – a company's rights and opportunities

Several specific source-reduction techniques in textile processing and fabrication were discussed, including:

- Raw Material Control
- Conservation/Optimization of Chemicals
- Chemical Substitutions
- Process and Equipment Modifications
- Housekeeping and Maintenance Procedures
- Waste Recovery for Reuse and Recycling

The conference also addressed the work of Dr. Frederick Golden, Professor of Apparel Production Management at the Fashion Institute of Technology.[6] Dr. Golden worked with the Apparel Research Committee (ARC) in outlining a variety of pre-production processes and cutting-room operation procedures that reduce fabric scrap at its source.

Dr. Golden's work focused on merchandising and design room issues pertaining to:

- Apparel Styling
- Construction
- Choice of Fabrics
- Specifications of Size
- Shading
- Quality Protection
- Computer-assisted Design and Marker Applications

He also focused on best-practice techniques for cutting department planning and operations using a systems approach.

Overview: The Development Team

FIT Textile Development and Marketing Department

This department offers a baccalaureate degree program leading to the bachelor of science degree with a highly flexible, interdisciplinary curriculum. It provides a broad overview of the textile industry as well as the study of a variety of textile applications.

Graduates of this program bring their in-depth knowledge of fabrics to the fashion-related careers they have been working toward. They go on to work in different segments of the fashion and design industries such as:

- Apparel Manufacturing
- Fiber Companies
- Retailers
- Home Furnishings Fabric and Fabric Producers

They also graduate with the necessary background and experience to pursue more specialized professional careers in fields such as:

- Product Development
- Marketing
- Fabric Coordination
- Structural Design and Styling
- Fabric Analysis
- Forecasting: Color, Trends, Technical Developments
- Quality Assurance
- Specifications Writing

LICBDC Industrial Waste Recycling and Prevention (INWRAP) Program

LICBDC is a not-for-profit business development organization dedicated to promoting the economic vitality and infrastructure of greater Long Island City. Formed in 1983 by local business and community leaders, LICBDC, as the manager of the Long Island City In-Place Industrial Park (IPIP) - NYC's largest and most diverse IPIP, succeeded in stabilizing the area's existing industrial employment base at a time when the communities throughout NYC experienced severe manufacturing job losses. LICBDC acts as an ombudsman on behalf of the entire area, sponsoring public events that increase the public's knowledge of Long Island City and that network area businesses. With over 200 members, LICBDC can help focus public attention on important local and regional issues. LICBDC offers the following services to members and area businesses:

- Ombudsman Services
- Annual Luncheon and Trade Show
- Committees
- High-Technology District
- Employment and Training Links
- Industrial Waste Recycling and Prevention Program
- Educational and Networking Events
- Area Planning and Development

The Industrial Waste Recycling and Prevention (INWRAP) Program began in the summer of 1993 to help businesses implement waste reduction and recycling programs. Since then, INWRAP has helped firms save up to $30,000 per year by reducing, reusing, and recycling their by-product and waste materials.

INWRAP serves a critical market niche creating solutions for businesses that:

- Do not have the in-house management capacity to design programs to minimize waste and improve productivity
- Are in danger of leaving New York or going out of business because of high costs
- Are small quantity generators of wastes and users of secondary materials
- Have problematic waste streams, which are difficult to reduce, reuse, and recycle

In recognition of its work, INWRAP has received awards from the U.S. Environmental Protection Agency Region 2, the City Club of New York, the National Council for Urban Economic Development, the National Recycling Coalition, the New York State Governor's Office, and the New York City Environmental Action Coalition.

Primary funding for INWRAP is provided by the Empire State Development Environmental Management Investment Group, the City of New York Department of Sanitation Bureau of Waste Prevention, Reuse and Recycling through the Industrial & Technology Assistance Corporation, and Consolidated Edison of New York and the shared savings and revenues of companies using its services.

Overview: The Industry

The textile industry is one of the nation's oldest dating back to the beginning of the American Industrial Revolution in the 1790s.

Textile manufacturing begins with the use of raw fiber. Fiber used in textiles can be harvested from natural sources (e.g., wool, cotton), manufactured from regenerative cellulosic materials (e.g., rayon, acetate), or it can be entirely synthetic (e.g., polyester, nylon). After the raw (natural or synthetic) fibers are shipped from the farm or the chemical plant, they pass through four main stages of processing:

- Yarn Production
- Fabric Production
- Finishing
- Fabrication (Apparel Manufacturing)

Depending on usage, yarns are first produced as either filament, multi-filament, or spun; with varying amounts of thickness, twist, and/or ply.

Fabric production, the second step, involves primarily either weaving or knitting. Broadwoven mills consume the largest portion of textile fiber and produce the raw textile material from which most textile products are made. Manufacturers of knit fabrics also consume a sizable amount of yarns.

Finishing represents the third step. For most uses, fabrics must undergo further processing, which can include scouring, bleaching, printing, dyeing and mechanical or wet finishing. Many different textures can also be obtained through the application of resins and sizings as well as through mechanical finishing.

Finally, the finished cloth is fabricated into a variety of apparel, household, and industrial products. The simplest of these products, such as bags, sheets, towels, blankets, and draperies, are often produced by the textile mills themselves. The sewn-products trades usually fabricate apparel and more complex home furnishings.

The textile industry is concentrated geographically in the South and Mid-Atlantic regions due their historic presence in these areas. For example, denim manufacturing is centered in the Southeast as well as the production of large commodity-type goods such as sheeting. However, considerable amounts of fabric dyeing and finishing still take place in New York, New Jersey and the New England states. Some of these operations are niche-market oriented.

The primary textile manufacturers that operate in this region are textile knitting, weaving, nonwoven operations, textile dyeing/printing, and finishing facilities. Within these firms the following types of equipment may be found in the New York metropolitan region: becks (box, winch), jigs, jets, beams, padders, screen printing, paddles (used for apparels), dry cans, tenter frames, and dry-finishing equipment.

Some of these systems may require the direct use of water, dyes, chemicals, and eventually machinery (energy) to dry these goods. In addition, there are indirect materials that are used in the manufacture or transport of the finished goods, i.e. tubes, pallets, and plastic wrap that must be considered. The apparel industry also has waste-generation streams that are linked to the handling (cutting and eventual shipment) of finished goods. These waste-generating processes are related to the type of goods, lengths of rolls, and fabric designs that are delivered to the cutting room facility.

Opportunities for Waste Reduction in the Industry

In general, there is fertile ground for the application of material optimization and source-reduction strategies to prevent waste generation within this industry. As noted earlier, New York City apparel firms and textile manufacturers generate approximately 384,000 tons of waste each year.[7] Our efforts should focus on better management of resources; such as reducing the consumption of raw materials and reusing or recycling materials whenever possible. The main goal is to lessen the waste stream while maintaining or improving upon product standards.

Several New York City firms have already realized examples of this goal. Within this guide we outline a sample of those companies which have been assisted by waste-reduction techniques and the resulting savings. One such firm, Marcus & Wiesen - a women's undergarment manufacturer, was generating three tons of lycra scrap per year which comprised its primary waste. The LICBDC INWRAP Program recommended several source-reduction and reuse strategies for optimizing lycra usage, thus lowering waste generation rates and disposal quantities. Modifications in the spreading and cutting operations, along with the substitution of a continuous spool system, were designed to minimize lycra, elastic, and corrugated-core waste. A reduced hauler collection schedule was recommended based on projected volume reductions.

The company realized a reduction in its generation of scrap lycra by 60 cubic yards per year, saving the firm $4,200 in purchasing costs. The installation of a continuous-feed elastic system reduced elastic discards by 11 percent, with an initial $950 per year savings. In addition, Marcus & Wiesen's reduced waste collection schedule lowered its annual hauler fees by $2,540.

With the challenge of the ever-growing trend of importing textiles and apparel from other areas of the world, streamlined operations will give NYC firms the edge to compete in the world economy. The region’s longevity is primarily due to its focus on quality assurance combined with timely production. Over time niche markets have developed and continue to exist in this region because of their special manufacturing techniques and end-use requirements. The close proximity of many manufacturers to the New York metropolitan region is not coincidental; it allows them to achieve quick turn-around times.

The following section outlines the waste streams, often categorized as primary and secondary, associated with both textile and apparel manufacturing firms.[8]

Textile Manufacturing - Primary Waste:

- Remnants
- Seam Waste
- Side Ends of Rolls
- Strike-off Fabrics
- Leader Cloth
- Fibers, Yarn
- Damaged Fabrics
- Excess Chemical and Dye Waste

Textile Manufacturing - Secondary Waste:

- Tubes
- Pallets
- Cones
- Chemical and Dye Drums/Containers
- Plastic Wrap
- Corrugated Cardboard
- Energy and Utility Use (Intangible)
- Paper Waste

Apparel Manufacturing - Primary Waste:

- Fabric/Remnants
- Sewing Thread
- Trimmings
- Samples
- Cuttings or Scraps
- Mill Ends

Apparel Manufacturing - Secondary Waste:

- Tubes
- Pallets
- Cones
- Shipping Cartons
- Paper Waste
- Bags
- Plastic Wrap

Although mentioned previously, inefficient use of utilities results in a waste that is not as obvious as extra fabric or paper waste.[9]

SECTION 2

OVERALL FINDINGS

Case Studies: Citations from the AATCC

Studies cited in the American Association of Textile Chemists and Colorists (AATCC) Review have shown that combined reductions in industrial by-products (textile cuttings, common recyclables, dyes, and chemicals), and effluent treatment by as much as 30% are possible.[10] Numerous recycling and waste-reduction projects have been completed, varying from reducing the amount of advertising mail delivered, to recovery and reuse of bleaching chemicals and reduction of chemical waste during fabric finishing. No capital expenditures are needed, just a careful evaluation of current practices and procedures. The following section introduces a few of the case studies, which are cited in the AATCC Review.

Case Study #1: Industrial By-Product Textile Cuttings - Milliken & Company

Background: A project to reduce waste/costs associated with textile cuttings

Findings:
A study of a piece goods operations process resulted in the following:

Apparel manufacturers can find remarkable efficiency gains by bringing a systems approach to cutting room operations according to the Apparel Research Committee of the American Manufactures Association (ARC). In practice, that simply means considering the cost consequences of each variable in the process.[11]

Selecting fabrics with symmetrical patterns enables simpler cutting as the marker can be placed one way or another. However, the marker can only be placed one way when asymmetric fabrics are cut guaranteeing fabric waste. Suppliers can be held to a consistent fabric quality level by defect mapping. Requiring shipment in packaging that keeps fabrics clean, unwrinkled, or uncreased, especially at beginning and end of roll, and protected from light damage, significantly reduces waste. Shade control should be monitored side-center-side as well as beginning-to-end of roll.

The systems approach has been profitably applied to weaving mill operations as early as the 1950s. A study, cited in a 1979 issue of Bobbin Magazine,[12] explained how a weaving mill went from a 300-yard to a 3000-yard roll of curtain fabric. The finishing plant no longer sewed together ten 300 yard rolls prior to the finishing processes, and no longer cut apart the individual rolls (with fabric waste) to reconstitute the original 300 yard rolls for delivery to the curtain factory.

The entire 3000-yard roll was hemmed on both sides simultaneously and automatically, thereby greatly reducing labor as compared with operators first hemming one side then hemming the other side in a second operation with its associated costly material handling of bundle movement, pick-up, sew, and dispose. The 3000-yard roll was then cut to length

automatically with just one potential remnant instead of 10, substantially cutting back on waste for a product with very long parts.

Fabric suppliers can ship large rolls of denim to major customers who could engineer their material handling systems to capitalize on the use of these giant rolls. The increases in length do not have to be as radical as the 3000 yards just described for other companies to achieve waste reduction through longer rolls and elimination of short pieces. Burlington offers rolls from 50 to 800 yards, with small-to-medium sized operations confining its purchases to 100-300 yard rolls. No one purchases full warps. Surprisingly, few companies take large rolls because most plants have not been engineered to handle them from receiving through spreading operations. This appears to be a missed cost-saving and waste-reduction opportunity.

Recently, Milliken, a textile firm making apparel and industrial fabrics, worked closely with apparel plants to find ways to reduce their waste and costs. It offers 250-yard or larger rolls, marks the actual width on each roll of cloth, strives toward zero defects, and helps engineer the needed material handling. Milliken figured that 3.5 cents per yard consumed was the potential savings from longer rolls of $2.50/yard fabric.

No longer is the extent of a person's reach a constraint on cutting width of fabrics. With computerized cutting, the width can really be any dimension leading to optimum material utilization. One major activewear company is able to fit five apparel across when cutting 120" warp knit vs. only two from 60" goods, or a total of four from two spreads of 60" goods, resulting in savings of time and money.

Wider goods can reduce preparatory, weaving, and inspection costs. Processing more square yards per running linear yard can lower finishing, spreading, and cutting costs. Milliken has successfully introduced wider goods via its wider looms working with sewing plants which were willing and able to increase the width of their cutting tables, eliminating one of the inhibitions to more widespread acceptance of wider goods.

General objectives of reducing textile cutting waste include:

- Optimum, uniform width
- Maximum practical length
- Minimum defects
- Protective packaging, with clean, uncreased ends at beginning and end of roll
- Minimum shade variation

There are pre-production processes that can affect utilization from cut planning to marker making. Production pattern engineering for fit, fullness, seam allowance, shape, seam location, and trim parts are all related to waste reduction.

Process areas, other than pattern engineering, affecting waste reduction include:

- Engineering repeats and adapting pattern placement to the repeat
- Number of separate cutting orders
- Size distribution and balance need for cut-downs
- Selection of widths and lengths of rolls for the cutting order

- Fabric receiving, inspection, defects mapping, storage, and inventory procedures
- Size combinations and sections in the marker
- Efficiency of marker making and use of computers
- Computer controlled cutting vs. hand cutting
- Targeting marker lengths
- Splice line placement and lap-loss control splice spreading
- Fabric constraints and alternatives related to grain-line maintenance and alternative cross-grain possibilities and fabric bias
- Use of remnants and efficiency of remnant lays
- Optimum use of width with minimum "edge" loss
- Section spreading
- Target marker lengths
- Employee training

Cutting room operations affecting utilization from spreading to bundling include:

- Controlling the front edge of a spread to prevent waste
- Controlling the amount of overlap on splicing
- Controlling the loss at turn back or cut-off at each end of the marker
- Locating of defects in fabric and decisions in cutting out defects
- Care in handling and moving bundles
- Effective computer and/or hand cutting
- Evaluating cutting gain and loss reports
- Evaluating efficiencies of centralized cutting practices where applicable, including disposal of remnants
- Employee training

Sewing room operations, finishing department, and warehouse practices affecting waste reduction include:

- Proper bundling of parts and finished goods handling to avoid dirt, cuts, etc. that result in fewer re-cuts
- Controlling use and waste of thread and trims, including ends of spools
- Evaluating operations to reduce waste of packaging and shipping materials
- Reducing seam-off cut waste (over-edge on knits, especially)

Case Study #2: Industrial By-Products / Common Recyclables - Cranston Print Works Co.

Background: A project to reduce waste/costs associated with common recyclables (paper, plastic, etc.) and generate revenue

Findings:
The study of a printing operations process resulted in the following:

- 500,000 pounds of cloth scraps are now collected, bundled, and sold rather than discarded to waste.
- About 150,000 pounds of paper per year are now being recycled including office paper, cardboard, and wood waste.
- Plastic coverings are also collected and recycled.

- Returnable dye and chemical drums are used. Larger volumes are delivered in reusable totes or in 1000-pound "supersacks".
- All employees, including plant union employees, have been trained to look for opportunities for improvement and to work in teams to realize these improvements.
- Returnable or bulk containers are used whenever possible.

Case Study #3: Industrial By-Products / Dyes and Chemicals; Cranston Print Works Co.

Background: A project to reduce waste/costs associated with dyes and chemicals

Findings*:*
The study of a printing operations process resulted in the following:

- Use of an automatic analyzer to sample, titrate, and automatically control the acetic acid metering pump resulted in the reduction in the use of acetic acid by 430,000 pounds per year (58%), and a one-year payback based on chemical and wastewater cost reductions. Project cost was $235,000.
- Finish mix wasted per lot was reduced from 86 gallons to less than 25 gallons.
- Projects through the Cranston's Webster printing plant have yielded overall water usage reduction of 30%.
- Diethylene glycol was reduced by 50% from 12 tons per year to less than 6 tons per year based on equal color usage amounts with subsequent reduction of plant VOC emissions.

Overall Recommendations/Tips:
- Target batchwise dyeing at the lowest possible liquor ratio.
- Telescope procedures and processes using well-known techniques.
- Eliminate the need for stripping and re-dyeing by maintaining a high level of right-first production.
- Use alternative procedures, such as pad dyeing, that will give equal quality.
- Consider which stage in dyeing, yarn, or piece dyeing gives the best results.
- Use a metering system for dyes and chemicals.
- Formulate chemicals for exact batch size.
- Use a spectrophotometer for shade matching.
- Sequence dyeing of similar colors to reduce stripping of dye equipment.
- Use safer alternative chemical systems which achieve similar results.

Case Studies #4-7: Effluent Treatment - Kufner Textilwerkein Weibkirchenlstmk Mill, Americal Corporation, Amital Spinning Corporation, Cranston Print Works

Background: A project to reduce waste/costs associated with wet processing.

Findings:
The study of a wet processing operations process resulted in the following:

A study of an Austrian textile mill, Kufner Textilwerkein Weibkirchenlstmk, showed that 10% of the process water could be saved by reusing cooling water. In addition, 20% of water usage could be avoided by optimizing the water use through better process control. Vacuum cleaning of the fabrics and reducing fiber content and spinning oils cut its chemical oxygen

demand (COD) on wastewater treatment, allowing dyeing baths to be reused rather than used once and then discarded.[13]

Americal Corporation, a dyehouse, replaced customary dyes and chemicals with less polluting alternatives that performed just as well, but substantially lowered Biochemical Oxygen Demand (BOD)**,** COD and Azo dyes**.** Modifying temperature and hold time improved exhaustion of dyes, reducing chemical and dye usage and also lowering BOD, COD, and Azo dye bath levels.[14]

Amital Spinning Corporation reused non-contact cooling water as process water, enabling dye liquors to be prepared at higher temperatures. Steam requirements and dyebath preparation time were reduced. Wastewater generated per pound of yarn dropped from 19.34 gallons to 3.19 gallons in 1992.[15]

Cranston Print Works employees noticed that smoke was building up inside the plant, as well as being vented to the air outside. They took the initiative to substitute process chemicals, and visible emissions were eliminated. Next they substituted a combination of carbon dioxide injection and biological oxidation for sulfuric acid as a pH neutralizer, resulting in the delivery of consistently buffered, equally loaded effluent to the town treatment plant. Without the use of 2.5 million pounds of sulfuric acid, chemical oxygen demand on the town treatment plant was sharply reduced, winning Cranston Print Works an environmental award from the Worcester Business Journal and the Massachusetts Audubon Society.

Case Studies #8-10: Energy Usage - a Queens dyehouse, Brooklyn dyehouse, and a Brooklyn garment manufacturer.

Background: A project to reduce waste/costs associated with utilities/energy

Findings:

The study of a wet processing operations process resulted in the following:

Easily overlooked is the cost of energy in textile and apparel production. Many government technical assistance programs, as well as private companies, can audit and assess energy use at a facility to identify areas of inefficiency and propose cost-effective solutions. On average, recommended actions from an assessment result in annual cost savings of about $55,000.[16]

A Queens dyehouse company had yearly energy costs of $367,000. More efficient lighting was installed at a cost of $16,000 with annual savings of $5,500. Steam pipes were insulated for $3,000 with annual savings in natural gas of $5,000. Wash water, originally draining to the sewer, was recovered for reuse at a cost of $285,000 resulting in the savings of $72,000 per year. In total, improvements that cost $326,600 to implement resulted in total savings of $112,400 per year.

At a Brooklyn dyehouse company, with yearly energy costs of $384,000, wash water was draining to the sewer, the overflow water consumption was too high, and dryers were not loaded to capacity. With these problems fixed at a $323,200 implementation cost, the firm saved a total of $129,000 each year.

A Brooklyn garment manufacturer learned its yearly energy costs of $74,500 was due to inefficient lighting with extremely high demand charges. Changing the lighting and staggering the switching of equipment resulted in a total savings of $15,000 per year with a $15,700 implementation cost.

Success Stories: A Selection of Companies Assisted By INWRAP

The following section outlines the benefits implementing waste reduction strategies have had on a sample of New York City textile and apparel firms.

Premier Brands of America

Premier Brands of America is an insole manufacturer that generated an average of 44 baled cubic yards (22 tons) of waste materials per month. As of June 1997, the company paid $1,248.00 per month in landfill disposal costs. As a result of INWRAP's initial assistance, Premier began segregating, baling, and recycling its five tons of corrugated materials per month. Its remaining 22-ton monthly waste stream composition was as follows:

Materials	Units	Baled Cubic Yards	Tons
Rubber Insole Cuttings [SBR♦ 60%; Latex 40%]	- - - -	14.0	7.0
Cork Sheeting [3'x3'x3']	- - - -	25.0	12.5
Misc. Materials	- - - -	5.0	2.5
TOTALS	**- - - -**	**44.0**	**22.0**

INWRAP's waste reduction and reuse report identified several options for Premier's insole cuttings and cork sheeting. Two regional foam products manufacturers, Crest Foam and Durafoam, expressed strong interest in using Premier's natural rubber latex scrap as a feedstock for their product lines. Since Premier could easily separate its natural rubber latex during the production process as well as store it for up to one month, the company was capable of diverting 40% of its insole scrap for remanufacturing reuse. The key problem for Premier was the transportation of these materials. However, both Durafoam and Crest had customers near Premier's facility and expressed a willingness to pick up its latex on a monthly basis. Transport, labor, and handling costs precluded the possibility of revenues for Premier, but the firm stood to divert 2.8 tons per month at a disposal cost savings $158.82 per month.

Several packaging material firms expressed interest in Premier's cork sheeting, most notably Wiltec, Inc. Wiltec was prepared to pay all shipping and handling costs for four tons per month of the cork sheeting. In addition, the Children's Museum in Los Angeles had begun an ongoing project producing children's beanbag chairs that required .8 tons per month of cork sheeting as a feedstock. Yemm & Hart, the consulting firm handling the project, was willing to pay for freight and processing. Both these options provided Premier with the potential to realize approximately $269.45 per month in disposal costs, while diverting 4.8 tons of waste material for reuse.

♦ SBR: styrene butadine rubber

One meeting was held with Premier production manager, controller, and president to review INWRAP's report and recommendations. At this June 1997 meeting, all three agreed to implement INWRAP's report recommendations and asked INWRAP staff to continue their search for reuse markets for styrene butadine rubber (SBR) insole cuttings and the remaining cork sheeting.

The chart below documents source-reduction and reuse tonnage, material-specific diversion rates and dollar values realized by Premier Brands of America from July of 1997 through September of 1998.

Dates	Material	Tons	Rate	Value
7/97-9/98	Rubber Insole Cuttings [SBR♦ 60%; Latex 40%]	36.0	86%	$2,041.97
7/97-9/98	Cork Sheeting [3'x3'x3']	52.5	73%	$2,947.10
TOTALS			**88.5**	**$4,989.07**

Gloria Lingerie

Gloria Lingerie was an undergarments manufacturer that generated 64 loose cubic yards (11.24 tons) per month of waste materials. The company paid an average of $692.80 per month in disposal costs in November of 1997. Its average monthly waste stream composition is broken down in the table below:

Materials	Units	Loose Cubic Yards	Tons
OCC♦	----	2.5	0.31
Textile Cone Tread Cartons (27" x 34" x 33")	30	14.0	0.5
Mixed Textile Cuttings (Nylon, Cotton and Polyester)	----	40.0	10.0
Textile Cones (Paperboard)	2,400	6.0	0.20
Misc. Materials [Non-Recyclable/Reusable]	----	1.5	0.23
TOTALS		**64.0**	**11.24**

INWRAP's waste reduction report identified three cost-saving and revenue-generating source-reduction and reuse opportunities for Gloria Lingerie fabric cuttings, textile cones and textile

♦ SBR: styrene butadine rubber
♦ OCC: old corrugated cardboard

cone cartons. Gloria used a manual system for marking, spreading, and cutting its nylon and polyester fabric. INWRAP's team identified approximately .75 to 1.0 inches of material that was being wasted during each lay-up. By tightening up the edges using smaller t-squares, this waste could be eliminated. The company paid an average of $3.00 per square yard, $1.20 per linear yard, and $.05 per linear inch for its fabric. On average, two pattern cuttings are performed each workday throughout a 250-day work year. All fabric is folded 108 times for each cutting and is laid-up in 90" widths.

The following formulas were used to calculate the amount of potential savings through optimizing the fabric usage:

- (.75 inch reduction - $.0375 per linear inch) x 216 folds/day x 250 workdays per year = $2,025.00

- (1.0 inch reduction - $.05 per linear inch) x 216 folds per day x 250 workdays per year = $2,700.00

In terms of material source-reduction, the following formula calculated Gloria's projected cubic yardage and tonnage figures:

- (.75 inch reduction - 0.0047 cubic ft.) x 216 folds/day x 250 workdays = 253.13 cubic ft.

- 9.38 cubic yds. x 500 lbs./cubic yard = 4,690 lbs. (2.34 tons)

- (1.0 inch reduction - 0.0063 cubic ft.) x 216 folds/day x 250 workdays = 340.2 cubic ft.

- 12.6 cubic yards x 500 lbs./cubic yard = 6,300 lbs. (3.15 tons)

Gloria textile thread cones were ideal for reuse and resale. The cones are 6 3/4" in length with a 1 1/2" opening at the top and a 3" circumference at the base. A vendor INWRAP had previously worked with in Philadelphia, Textile Cones, Inc., bought these type of cones at $.08 per lb. for resale to North Carolina textile mills. Gloria generated approximately 4,800 lbs. of textile thread cones per year. At $.08 per lb. it stood to receive $384.00 in revenues and save $779.40 in disposal costs by selling the cones to Textile Cones, Inc., a firm from Philadelphia. The company also generated approximately 30 triple-walled textile thread cone cartons in excellent condition each month. Several INWRAP materials exchange companies, such as Ben Forman and Son, United Shipping and Packing, and Foremost Corrugated were willing to pick up and pay $2.00 per carton.

Three meetings were held with Gloria president and its production personnel in October and November of 1997. All of INWRAP's source-reduction and reuse report recommendations were agreed upon for implementation. Gloria Lingerie lay-up and cutting department began tightening up the edges of its nylon and polyester fabric in late November. In early December, we arranged for Foremost Corrugated Job Lot Division to begin purchasing Gloria textile thread cone containers. Textile Cones, Inc. made the first collection of these cones in April of 1998.

The following chart documents source-reduction and reuse tonnage and material-specific diversion rates, along with dollar values realized by Gloria from December of 1997 through September of 1998.

Time Period	Material	Tons	Rate	Value
12/97-9/98	Mixed Textile Textiles (Nylon, Cotton & Polyester)	2.5	3%	$1,958.33(Pur. Savings) $108.25(Disposal Savings)
12/97-9/98	OCC, Textile Thread Cone Cartons (27" x 34" x 33")	4.0	80%	$480.00
4/98-9/98	Textile Cones (Paperboard)	1.0	80%	$311.76 (Disposal Savings) $153.60 (Revenues)
TOTALS			**7.5**	**$3,011.94**

The following chart references an additional list of textile and apparel manufacturing firms with a variety of waste streams that have been assisted by INWRAP in reducing their waste with resultant savings.

Company	Material Reductions	Dates	Quantity(s) [+]	Total Rev./ Savings in $ [*]
Samex Corp.	Mixed Cotton & Acrylic Textile Cuttings	1/98 - 12/99	197.0 tons 1,185.6 yds3	8,220.49 [Savings]
Sequins Int'l	OCC, Sequins, Glitter, Honeycomb Rolls & Wood Scrap	1/98 - 12/99	225.2 tons 1,763.5 yds3	19,983.97[Savings]
Salant Accessories	Silk Trimmings, OCC & HGP[♦]	1/98 - 12/99	183.8 tons 1,829.4 yds3	17,222.09[Savings]
Lord West	OCC, Wool Trimmings & Paperboard Tubes	1/98 - 12/99	242.8 tons 1,713.4 yds3	27,845.29[Savings]
Venus Trimming & Binding	Paperboard & Plastic Spools & Cones, Pleating Paper, OCC	9/98 - 12/99	47.5 tons 370.5 yds3	10,942.50[Savings]
TOTALS			**896.3 Tons**	**$84,214.34**

[+] Cubic yardage (yds3) quantities are calculated on a loose, not compacted, basis.

[*] Total revenues/savings = gross generator purchasing and disposal cost savings, including revenues where applicable.

[♦] HGP: high grade paper

Recommendations: Waste Stream Reduction Practices for Textile and Apparel Manufacturers

The following suggestions are steps that manufacturers can take to align themselves with better practices. In later discussions, there are specific examples and more detailed proactive steps these firms can take to reduce their waste stream and costs.

Procedures To Develop a Comprehensive Waste Management System[17]

Create a corporate waste committee:
- Gather a representative from each process area
- Hold monthly meetings and reviews

Create one central area collection point:
- Gather all cut/sew waste
- Separate and classify waste for sale/shipment to specific vendors (see page 25, How to Handle your Operational Wastes)

Perform a corporate waste report (analysis) by:
- Preparing monthly documentation of waste levels compared with standards

Assign staff (one or more people depending on quantity of waste streams):
- To monitor waste for all process areas (Textile & Apparel)
- To obtain feedback to each area for possible improvement or recognition of improvement (Communications)

Design internal adjustment and development of equipment/machinery:
- Make pattern modifications to maximize raw materials usage and minimize waste
- Investigate, experiment, and monitor the effects of these modifications

Create training documents:
- Prepare a corporate waste procedure handling manual and an awareness video for use in training for all apparel plants.

Develop a computer system:
- To track/record all fiber/fabric waste information and inventory

Techniques to Reduce Industry Specific Waste: [18]

To reduce waste from end-of-roll length cut off fabric:
- Obtain longer roll sizes from weaving facility
- Utilize better sewing techniques when joining rolls
- Cut samples for testing from an area that won't produce shorts

To reduce seam waste:
- Cut fewer seams between rolls
- Use large rolls from greige goods source

- Cut off side-ends of rolls for a clean edge
- Greige fabric should be woven or knit to tighter specification width

To reduce strike-off fabrics:

- Use a spectrophotometer to ensure more accurate color matching

To conserve energy:

- Use counterflow washing in washboxes (water)
- In Beck's, save final rinse water for next batch
- Use primary dyes (red, yellow, and blue) with similar strike rates to reduce dye cycles
- Use moisture monitors on dryers, especially dry cans - using less energy for drying (No need to over-dry fabrics)

How to Handle Specific Operational Wastes (i.e., industrial by-products or surplus materials):

Cones:

- Use longer yarn yardage for winding operation
- Ship to source if in good condition
- Ship to recyclers

Chemical & dye drums/containers:

- Use larger drums for delivery
- Use fewer types of chemicals to achieve same result
- Reduce the number of workhorse dyes

Leader cloth:

- Find use in other areas of operation

Pallets:

- Repair pallets for further use
- Ship good pallets to originator
- Ship to a pallet refurbisher
- Ship pallets to recycler

Plastic wrap:

- Reuse in house whenever possible
- Ship to recyclers

Tubes:

- Send tubes back to supplier
- Ship to recyclers

Yarn:

- Wind excess yarns on spools for reuse or for recyclers

How to Handle Office Waste (i.e., paper, common recyclables):

Paper waste:
• Use in-house electronic correspondence
• Make double-sided documents
• Reuse paper in house
• Set up a convenient recycling drop-off location
• Schedule a regular pickup with local commercial recycler

Common Recyclables: (aluminum cans, glass containers, etc.)
• Set up a convenient recycling drop-off location
• Rinse and sort materials
• Schedule a regular pickup with local commercial recycler

Next Steps

Despite the numerous resources available to textile and apparel manufacturers in New York City, the services remain underutilized and the industries still suffer from inefficient systems. The findings discussed in this guide point to the need for a comprehensive waste-reduction outreach and implementation program for these industries. [19]These following are suggestions to implement a program of this nature.

- Designate a host organization and waste prevention coordinator for a New York City textile waste reduction program
- Establish a management team committed to the program
- Organize a working team to lead the waste prevention program
- Set goals and priorities for the waste reduction program
- Develop a comprehensive waste reduction action plan
- Develop a process flow diagram
- Implement the action plan
- Expand the plan to meet future goals and priorities

This guide considers two main types of textile operations, fabric finishing and fabrication of products. Dyeing, printing, and finishing facilities add color or change the appearance and/or performance of manufactured greige goods. These dyed/printed and finished fabrics will eventually find their way to the cutting room tables to be assembled into apparel or other types of consumer ready textile products. The new waste reduction program should concentrate on these operations.

Appendix A

Successful Apparel and Garment Waste Reduction Practices[20]

The following was developed by INWRAP to assist industrial firms and distributors in assessing their operations.

- Set up a comprehensive fabric inspection system to monitor and limit width and shade utilization, spreading losses, and re-cut controls
- Tighten up edges to reduce waste in cutting fabric during layout
- Improve front edging of plies on front of the spread
- Identify minimum widths through manual, mechanical, or electronic devices
- Establish economic width-sorting guidelines
- Establish shade classifications, tolerances, and examination procedures
- Analyze the effects of shade segregation on ply-numbering costs, bundle size, remnant losses, recuts and seconds
- Establish width/shade labor and material break-even charts
- Analyze pattern sets and marking rules to effect fabric economies
- Maintain high inventory to insure those larger cuts can be issued
- Plan piece good deliveries to insure that fabrics that can be cut together are received within the same cut-planning period
- Use continuous spools of elastic
- Backhaul or send back spools, bolt cores, and boxes to the supplier
- Make changes in packaging of fabric to reduce waste
- Reuse notion boxes to send products to consumers
- Replace cardboard trays for transporting stacks of apparel to plastic ones
- Recycle unused fabric and remnants

Appendix B

Key Practices for Waste Reduction[21]

The following was developed by INWRAP to assist industrial firms and distributors in assessing their operations.

Inventory Management

- When purchasing items, consider what you will have to dispose of and what can be recycled.
    - Are there materials substitutes that can be more easily recycled? Do various supplies come packaged differently?
    - Can you favor suppliers who minimize excess packaging material or work with regular vendors to identify ways of reducing waste?

- Purchase only what you need in terms of supplies. This eliminates spoilage and over-production.

- Purchase nontoxic products whenever possible. This may represent significant savings in terms of costly and complicated disposal costs.

- Buy products that are recyclable, thus reducing your waste and your disposal costs.

- Work with suppliers to schedule deliveries so that materials are shipped and immediately unpacked so that packing materials can be returned to suppliers for reuse.

- Buy products in bulk to reduce packaging and waste handling costs.

- Wherever possible, buy supplies in concentrate form that can be diluted and used in reusable containers.

- Wherever possible, use containers that can be stored and returned to the vendor to be refilled.

- Use durable, reusable, or repairable packaging materials whenever possible.

- Evaluate whether incoming packaging may be reused for outgoing shipments.

- Consider waste handling and disposal factors when evaluating various purchases.

- Heavy packed supplies should be discouraged in favor of lesser-packed competitors.

Key Practices for Waste Reduction (continued)

Operations

- Wherever possible, change production inputs to ones that reduce the amount of waste generated or the composition or toxicity of waste.

- Reuse waste within your operation. Determine if any waste from production processes can be recycled internally within your own system.

- Inspect and clean equipment regularly to extend its useful life and maximize productivity.

- Reduce paper usage
    - Copy documents on both sides of the page.
    - Post inter-office memos instead of circulating individual memos to all employees.
    - Reuse backs of paper for draft documents or note pads to minimize paper purchasing costs and waste volume.

- Send bills in two-way envelopes that allow receiver to use same envelope, thus reducing waste and purchasing and processing costs.

- Purchase or lease new equipment or modify existing equipment to increase efficiency and reduce waste.

- Sell or donate surplus items to charitable organizations and get a tax deduction.

Resource Management

- Ensure that every employee understands and is responsible and accountable for incorporating environmental quality considerations in operational activities.

- Retrain employees and managers to revise work habits that create excess waste.

- Evaluate internal reporting paperwork and eliminate unnecessary processes wherever possible.

- Set semi-annual or annual waste generation guidelines for individual units or department managers to create waste reduction objectives and incentives.

Appendix C

Questions to Consider[22]

The following questions were developed by INWRAP to assist textile and apparel manufacturers in assessing their purchasing, operations, waste management and recycling practices.

- Are your collected waste materials loose, compacted or baled?
- Do you use dumpsters, boxes, or other containers for your loose waste?
- How many collections of what size containers do you have on average per month, slow season versus busy season?
- Do you know how much you pay per cubic yard, or do you have a flat rate agreement?
- Are you serviced on an on call basis or on a regular weekly schedule?
- How many collections of what volume of material and what price?
- What is the average size of the textile scrap pieces that you generate?
- What is your mix of yarn scrap?
- On average, how much cotton, rayon, etc., and mixed percentages do you have in slow season average versus busy season. Is there any stitching present in your scrap? If so, approximately what percentage of scrap has stitching?
- Do you generate any other fabric scrap besides yarn? If so, what materials in approximately what amounts per month?
- Are you segregating your scrap by fiber type? If so, how much of your total scrap are you separating on average?
- What are the estimated mixes and percentages of fabric scrap that is being separated?
- What is not being separated?
- Approximately how much textile scrap do you generate per month in cubic yards? Is it presently being recycled? If so, is it collected at no cost?
- Do you receive any revenues for your scrap?
- What type(s) and quantities are being recycled?
- What textile and non- textile materials are being thrown in your dumpster/compactor and in approximately what quantities?
- How do you receive your bulk yarn shipments?
- Is the yarn shipped by common carrier, contracted freight, or some other method? What are the approximate dimensions of your yarn boxes/cartons?
- Are the boxes/cartons recycled at no cost, given away for reuse, or sold? Are your yarn cones individually packaged in plastic bags? If so, are the cones sealed in these bags? Are most of the bags in good condition?

Appendix C
(Continued)

Questions to Consider[23]

- How many bags per month - average? What are the dimensions of the bags, approximate size(s), thickness, etc.?
- What do you do with the plastic bags?
- What types of yarn cone waste do you generate? (Plastic, paper)
- What are the sizes/dimensions of the cones?
- Approximately what volume of what kinds are generated each month?
- Are any collected for reuse/recycling without cost? If so, which ones and in what amounts?
- Do you generate any spool waste? If so, what types of material are the spools; what are their dimensions and in what approximate quantities? Typically, how much textile material is left on each cone and/or spool when it's spent? Have you looked into any continuous-feed systems to reduce or eliminate this waste?
- Do you use materials for internally transporting products through the manufacturing process that become waste? (pins to hold apparel together; chipboard paper, etc.) What other packaging wastes do you generate? (pallets, stretch film/shrink wrap, etc.)

Appendix D

Waste Evaluation Survey[24]

The following survey was developed by Cyntex, Inc. to assist textile and apparel manufacturers in assessing their operations and waste management practices.

Date:_____

Company Information:

Name:_____ Address:_____

Fax:_____ Street:_____

Contact Name:_____ City:_____

E-mail:_____ State:_____

Title:_____ Zip Code:_____

Telephone #:_____

Ext:_____

Commodity Description:

Location(s):

Site A:_____

Site B:_____

Site C:_____

Commodity Type:

(Description):_____

Fiber Content:_____

Weight per square yard of material:_____

Why is it Waste?_____

Original Usage:_____

Woven(circle one) Yes No

Original Width:_____

Knitted (circle one) Yes No

Non-Woven (circle one)Yes No

Waste Minimum Dimensions:_____

Waste Maximum Dimensions:_____

Put-Up:_____

Packing:_____

Do you have a baler? (circle one) Yes No

Weekly Volume:_____

Annual Forecast:_____

Present Disposition:_____

Present Selling Price:_____

To Whom?_____

Appendix E

Resources in Print: Selected Textile and Apparel Waste Reduction

The following resources were compiled by INWRAP for the purposes of this guide.

"A Comprehensive Material Utilization Study: Parts 1 and 2." *Apparel Manufacturer*, May and August 1989.

"Achievements in Source-reduction and Recycling for Ten Industries in the United States." Tillman, J. W., A. Robertson, and E. L. George, Science Applications International Corp., U.S. EPA, DOC EPA-68-C8-0062; EPA-600/2-91/051, September 1991.

"Apparel Care and the Environment: Alternative Technologies and Labeling." U.S. EPA, DOC EPA-744/R-96/002, September 1996.

"Best Management Practices for Pollution Prevention in the Textile Industry." U.S. EPA, DOC EPA-625/R-96/004, September 1996.

Choose to Reuse: An Encyclopedia of Services, Products, Programs & Charitable Organizations That Foster Reuse. Goldbeck, Nikki & David. Ceres Press, New York: 1995.

Cutting Room Update, Part I and Part II. Kurt Salmon Associates. New York: March 1990.

Don't Overlook Textiles! Council for Textile Recycling. Maryland: 1997.

"Filtration Techniques Used by the Textile Industry for Recovery of Dyes, Chemicals and Energy." Porter, J.J., Clemson University School of Textiles, U.S. EPA, DOC EPA, 1995.

"Generation and Management of CESQG Waste." U.S. EPA, DOC EPA-68-W3-0008; EPA-530/R-95/017, July 1994.

"Going Organic: Converting Patagonia's Cotton Product Line." Chouinard, Yvon, and Brown, Michael. *Journal of Industrial Ecology*, Vol. 1, No 1, 1997.

"Handling Difficult Materials: Textiles." Polk, Tom. Waste Age, July 1994.

"How to Recycle or Reuse Almost Anything." The City of New York, Department of Sanitation - Bureau of Waste Prevention, Reuse and Recycling. New York: 1994.

Appendix E
(Continued)

Resources In Print: Selected Textile & Apparel Waste Reduction

"Massachusetts Weaver's Waste Filters into New Product Line." McCurry, John W. *Textile World*, August 1995.

Materials Management in Clothing Production. Tyler, David J., Blackwell Scientific Publications Professional Books, Cambridge, MA: 1991.

Material Utilization in the Apparel Industry: Current Practices and Recommendations for the Future, Apparel Research Foundation, Inc., 1970.

"*Patterns for Fabric Economy."* Havinoviski, Mara. Bobbin Text Book Series, 1969.

"Potential for Source-reduction and Recycling of Halogenated Solvents: A Report on Research Performed by the Source-reduction Research Partnership for the Metropolitan Waste District of Southern California and the Environmental Defense Fund, Jacobs Engineering Group, California: 1992.

"Pricing Environmental Impacts: A Tale of Two T-shirts," *Illahee*, Volume 11, Numbers 3 & 4, 1995.

"Profile of the Textile Industry: Sector Notebook Project", U.S. EPA, DOC EPA-310/R-97009

"Recycle-If You Can." Kron, Penny. *Apparel Industry Magazine*, September 1992.

"Recycling: Saving Money and the Environment." Elliot, Edward J. *Textile World*, February 1996.

"Recycling Should Be Your Last Resort, Says EPA." Kalogeridis, Carla. *Textile World*, Vol. 141, June 1992.

"SIC 2200-2300: Textile Mill Products & Apparel/Other Finished Products Case Studies." Office of Waste Reduction- Pollution Prevention Program, North Carolina Department of Environment, Health and Natural Resources, North Carolina: September 1993.

"Survey of Dyes and Chemicals Used in the Hosiery Industry." National Association of Hosiery Manufacturers. North Carolina Department of Natural Resources & Community Development, North Carolina: May 1995.

"Starting Continuous Improvement with a Cleaner Production Assessment in an Austrian Textile Mill." Fresner, Johannes. *Journal of Cleaner Production*, No. 6, 1998.

"Textile Waste." Groff, Kimberly A. *Water Environment Research*, Vol. 64, June 1992.

Appendix E
(Continued)

Resources In Print: Selected Textile & Apparel Waste Reduction

"Textile Recycling Fact Sheet." Council for Textile Recycling. Maryland: 1997.

"Textile Recycling 101." *Scrap Processing and Recycling*, Winchester, Sarah Hart. May/June 1995.

"Textile Recycling." Jablonowski, Ed and Carlton, John. *Waste Age*, January 1995.

"Trade Associations and Textile Schools." *Textile World*, July 1995.

Waste Reduction in the Textile & Apparel Industries. East Williamsburg Valley Industrial Development Corporation. New York: 1996.

WasteWise Textiles Case Studies: Johnston's Industries, Springs Industries, Inc., Cone Mills Corporation, Dan River, Inc." U.S. EPA, DOC EPA-530-N-97-008, 1999.

"What To Do With Hard-To-Recycle Items: Organizational Resources Fact Sheet." Upper West Side Recycling Center Inc., New York: 2000.

"Waste Recycling in the Textile Industry." National Technical Information Service, Citations from the *World Textile Abstracts Database*, NTIS, 1989.

Weaving Textile Reuse Into Waste Reduction. Platt, Brenda. Institute for Local Self-Reliance, Washington DC: 1997.

Appendix F

Resources on the Internet: Organizations Providing Textile and Apparel Waste Reduction Information, Products, Services

The following resources were compiled by INWRAP for the purposes of this guide.

American Association of Textile Chemists and Colorists
One Davis Drive
P.O. Box 12215
Voice: 919-549-8141
Fax: 919-549-8933
Email: info@aatcc.org
www.aatcc.org

American Textile Manufacturers Institute
1130 Connecticut Avenue, NW Suite 1200
Washington, DC 20036-3954
Voice: 202-862-0500
Fax: 202-862-0570/0537
ATMI FactsLine: 202-862-0572
www.atmi.org

Council for Textile Recycling
7910 Woodmont Avenue, Suite 1130
Bethesda, MD 20814
Voice: 301-656-1077
Fax: 301-656-1079
www.textilerecycle.org

CYNTEX Company
P.O. Box 716
Hartsdale, New York 10530-0716
Voice: 914-472-4922
Email: Scottrags@aol.com
www.cyntexco.com

Fashion Institute of Technology
Textile Development and Marketing Dept
Seventh Avenue at 27 Street
New York, New York 10001-5992
Voice: 212-217-7686
Fax: 212-217-7593
www.fitnyc.suny.edu/academic/all_majo/2.11.09.html

Garment Industry Development Corporation
275 Seventh Avenue, 9th Floor
New York, New York 10001
Voice: 212-366-6160
Fax: 212-366-6162
Email: gidcinfo@gidc.org
www.gidc.org

Institute for Local Self-Reliance
2425 18th Street, NW
Washington, DC 20009
Voice: (202) 232-4108
Fax (202) 332-0463
E-mail: ilsr@igc.org
www.ilsr.org

INDA: Association of the Nonwoven Fabrics Industry
P.O. Box 1288,
Cary, NC 27512-1288
Voice: 919-233-1210
Fax: 919-233-1282
www.inda.org

Industrial & Technology Assistance Corp
Apparel & Sewn Products Manufacturers Program
253 Broadway, Room 302
New York, New York 10007
Voice: 212-240-6920
Fax 212-240-6849
Email: info@itac.org
www.itac.org

Appendix F
(Continued)

Resources on the Internet: Organizations Providing Textile and Apparel Waste Reduction Information, Products, Services (continued)

Industrial & Technology Assistance Corp.
New York Wa$teMatch Program
253 Broadway, Room 302
New York, New York 10007
Direct Voice: Line 212-240-6966
Fax: 212-240-6879
www.wastematch.org

Long Island City Business Development Corp.
Industrial Waste Recycling and Prevention (INWRAP) Program
29-10 Thomson Avenue, 9th Floor
Long Island City, New York 11101
Voice: 718-786-5300
Fax: 718-937-1799
Email: inwrap@licbdc.org
www.inwrap.org

Recycler's World / RecycleNet Corp
Textiles and Leather Recycling Section
P.O. Box 1910
Richfield Springs, NY 13439
www.recycle.net/Textile/index.html

Recycling Markets & Recycled Products Guide
P.O. Box 577
Ogdensburg, NY 13669
Voice: 800-267-0707
Fax: 877-471-3258
Email: info@recyclingdata.com
www.recyclingmarkets.net

SMART & The Shippers of Recycled Textiles, Inc. (SORT)
7910 Woodmont Avenue, Suite1130
Bethesda, MD 20814
Voice: 301-656-1077
Fax: 301-656-1079
Email: smartasn@erols.com
www.smartasn.org
www.sorti.com

Textile FiberSpace
P.O. Box 24017
Guelph, Ontario
Canada, N1E 6V8
Voice: 519-767-2913
www.textilefiberspace.com

Wastesaver.com
1 Union Square West, Suite 810
New York NY-10003
Voice: 212-645-9912
Fax: 212-645-9915
Email: support@wastesaver.com
www.wastesaver.com

Worldwide Responsible Apparel Production (WRAP)
200 North Glebe Road, Suite 1010
Arlington, VA 22203
Voice: 703-243-0970
Email: INFO@Wrapapparel.org
www.wrapapparel.org

WasteWise Program (5306W)
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
Voice: 800-372-9473
Fax: 703-308-8686
Email: ww@cais.net

Textile Industry Section of EPA Website
www.epa.gov/epaoswer/non-hw/reduce/wstewise

END NOTES

[1] Source: Source: Union of Needle Trades, Industrial and Textile Employees, 1996.
[2] Source: City of New York Department of Sanitation, "NYC Waste Composition Study, Commercial Sector", Volume 4, 1992.
[3] Source: American Textile Manufacturers Institute, "ATMI 1998 Waste Generation Survey", October 2000.
[4] Source: North Carolina Department of Environment, Health, and Natural Resources - Office of Waste Reduction, Case Studies SIC 2200-2300: "Textile Mill Products & Apparel/Other Finished Products". September 1993.
[5] Source: North Carolina Department of Environment, Health, and Natural Resources - Office of Waste Reduction, Case Studies SIC 2200-2300: "Textile Mill Products & Apparel/Other Finished Products". September 1993.
[6] Note: Dr. Golden is familiar with, or has contributed to, a variety of seminal, industry-specific waste reduction and material utilization publications. These works include Material Utilization in the Apparel Industry, Patterns for Fabric Economy and Materials Management in Clothing Production.
[7] Source: City of New York Department of Sanitation, NYC Waste Composition Study, Commercial Sector, Volume 4, 1992.
[8] Source: To Riches From Rags Conference Proceedings
[9] Source: Hofstra University Department of Industrial Assessment Center, a program of the Federal Department of Energy
[10] Source: " American Association of Textile Chemists and Colorists AATCC, Glover, G and Hill, "Waste Minimization in the Dyehouse, Volume 6, June 1993.
[11] Source: Apparel Research Committee of the American Apparel Manufacturers Association, Task Group Report - "The Environment", 1997.
[12] Source: Apparel Research Committee of the American Apparel Manufacturers Association, Task Group Report – "The Environment", 1997.
[13] Fresner, J. "Starting continuous improvement with a cleaner production in an Austrian textile mill." *Journal of Cleaner Production* Volume 6, 1998.
[14] Source: North Carolina Department of Environment, Health, and Natural Resources- Office of Waste Reduction, Case Studies SIC 2200-2300: "Textile Mill Products & Apparel/Other Finished Products". September 1993.
[15] Source: North Carolina Department of Environment, Health, and Natural Resources- Office of Waste Reduction, Case Studies SIC 2200-2300: "Textile Mill Products & Apparel/Other Finished Products". September 1993.
[16] Note: Results are based upon participants of Hofstra University's Department of Industrial Assessment Center (IAC) program.
[17] Source: Russell Corporation's Procedures for Comprehensive Waste Management, Apparel Research Committee of the American Manufacturers Association, Task Group Report – "The Environment", 1997.
[18] Note: Findings are based upon the proceedings of the "To Riches From Rags" conference, 2000.
[19] Note: Findings are based upon the proceedings of the "To Riches From Rage" conference, 2000. Proceedings.
[20] Source: LICBDC INWRAP report, "Apparel and Textile Suggestions for Reducing Your Waste and Saving Your Company Money," 1994.
[21] Source: LICBDC INWRAP report, "Best Practices" reference file, INWRAP, 1999.
[22] Source: LICBDC INWRAP report, "Best Practices" reference file, NWRAP, 1999.
[23] Source: LICBDC INWRAP report, "Best Practices" reference file, INWRAP, 1999.
[24] Source: Cyntex, Inc. survey, "Waste Evaluation Survey" reference file, Cyntex/Survey, 1997.