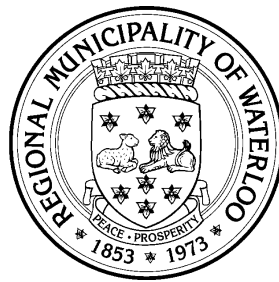


The Regional Municipality of Waterloo

Report on Automated Fibre Sorting Technologies

(WDO Project Code: OPT-R2-11)



**Prepared by:
Waste Management Division
Transportation & Environmental Services Department
Regional Municipality of Waterloo
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Project Team:

*Dan Balfour, Mike Ursu - Region of Waterloo
Herb Lambacher, Mark Rathbone - HGC Management*

Contributor:

Mike Birett - Region of Waterloo

Special thanks to our site visit hosts:

*Peter McMahon - Waste Recycling Inc, Ottawa
Eric Root, Regional Waste Systems, Portland (Maine)
Tony Joseph, Great Lakes Recycling, Detroit
Jim Kent, Canadian Waste Systems, Mississauga
Warren Whale, WasteCo, Brampton*

For more information, please contact:

Dan Balfour
Waste Operations Manager
Regional Municipality of Waterloo
E-mail: bdan@region.waterloo.on.ca
(519) 575-4776

EXECUTIVE SUMMARY

Recycling of newsprint, cardboard and boxboard involves labour-intensive sorting at many materials recycling facilities. The most common system in use is a conveyor line with numerous sorters to pick out cardboard, boxboard and contamination - leaving the newsprint to be conveyed to a storage bunker. Sorting tables are also used for manually sorting fibres.

Automated materials separation technologies developed specifically for fibre recycling have become more widely used recently in the belief that they are more cost effective for sorting fibres into their marketable components.

The objective of this project was to study these technologies and to make recommendations regarding their application at materials recycling facilities in Ontario. To this end, equipment suppliers were contacted to provide information on state-of-the-art systems available to sort fibres. The result was that one technology - **disk screens** - was recommended by suppliers.

Disk screens have been used in construction and industrial applications for years. For the recycling industry, two general types of disk screens have been developed to sort fibres: cardboard and newsprint screens. Disk screens have also been developed for single stream recycling systems to separate the containers from the fibres.

Four equipment suppliers provided information on their disk screen systems, following which visits were made to facilities where their systems were installed. All four suppliers used conveyor lines to move material - with disk screens installed at strategic points to sort the desired fibres into "overs" and "unders". Manual sorters were used before and/or after each disk screen to pick out cardboard, boxboard and contamination.

The outcome was that disk screens were clearly capable of separating fibre materials by size but had limited ability to separate cardboard and boxboard from newsprint - these materials still had to be manually picked out to a large extent. The size separation also resulted in flyers and other newsprint grade fibres falling through as "unders" into a less valuable mixed grade.

This means that materials recycling facility operators must carefully weigh the added costs of disk screens and loss of market revenues against the potential benefits of reduced labour and higher throughput. Also, the higher costs for disk screen systems may only be justified for facilities with high fibre volumes - more than 100 tonnes per day.

This report will be useful to materials recycling facility operators - both municipal and private - who are interested in understanding how disk screen systems compare to manual sorting systems, and the key factors to consider in deciding which system to choose.

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1. INTRODUCTION

Recycling of newsprint, cardboard and boxboard involves labour-intensive sorting at many materials recycling facilities. The most common system in use is a conveyor line with numerous sorters to pick out cardboard, boxboard and contamination - leaving the newsprint to be conveyed to a storage bunker. Sorting tables are also used for manually sorting fibres.

Automated materials separation technologies developed specifically for fibre recycling have become more widely used recently in the belief that they are more cost effective for sorting fibres into their marketable components.

Objective

The objective of this project was to study these technologies and to make recommendations regarding their application at materials recycling facilities in Ontario. To this end, equipment suppliers were contacted to provide information on state-of-the-art systems available to sort fibres. The result was that one technology - **disk screens** - was recommended by suppliers.

Disk screens have been used in construction and industrial applications for years. For the recycling industry, two general types of disk screens have been developed to sort fibres: cardboard and newsprint screens. Disk screens have also been developed for single stream recycling systems to separate the containers from the fibres.

Background

The Region of Waterloo operates a materials recycling facility that processes 80 tonnes of fibres daily from municipal blue box collections. All fibres are collected together in each recycling truck - newspapers, cardboard, boxboard, magazines, fine papers, phone books and paperbacks.

Fibres are processed manually at the facility using sorting tables into marketable components in the following approximate quantities:

newsprint	85%
cardboard	10%
boxboard	5%

The sorting table system has proven to be an effective and low cost way of processing fibres, however there are some drawbacks - mainly ergonomic and throughput - which prompted a review of other processing methods to determine if a change was warranted.

The *Waste Diversion Organization* provided financial assistance to the Region of Waterloo for this Fibre Sort Project to benefit other materials recycling facility operators in Ontario.

2. APPROACH

An Expression of Interest was sent to equipment suppliers to obtain information on systems available to sort fibres. Four companies provided information on their disk screen systems, following which visits were made to facilities where their systems were installed. A literature search was also conducted to obtain up-to-date information on fibre sorting technologies (see Appendices).

Equipment Suppliers

All four companies provide system design services to materials recycling facilities in Ontario. They manufacture both cardboard and newsprint disk screens for fibre sorting systems:

Bulk Handling Systems
CP Manufacturing
Machinex
Van Dyk Bollegraaf

Equipment supplier information is provided in the Appendices.

Site Visits

Visits were made to materials recycling facilities where each supplier had their equipment installed to sort newspapers, cardboard, boxboard and other household fibres:

<u>Facility</u>	<u>Location</u>	<u>Supplier</u>
Regional Waste Systems	Portland (Maine)	Bulk Handling Systems
Great Lakes Recycling	Detroit	CP Manufacturing
WRI	Ottawa	Machinex
Canadian Waste Systems	Mississauga	Van Dyk Bollegraaf

All four facilities used conveyor lines to move material - with disk screens installed at strategic points to sort desired fibres into “overs” (conveyed over the disks) and “unders”(fell through the disks to conveyor below). Manual sorters were used before and/or after each disk screen to pick out cardboard, boxboard and contamination. While systems varied, the fibres were typically processed in the following sequence:

Cardboard Disk Screen	- Overs conveyed to Cardboard bunker - Unders conveyed to Newsprint Disk Screen
Newsprint Disk Screen	- Overs conveyed to Newsprint bunker - Unders conveyed to Mixed Paper bunker

Site visit information is provided in the Appendices.

3. FINDINGS

It was generally found that disk screens were capable of separating fibre materials by size but had limited ability to separate cardboard and boxboard from newsprint - these materials still had to be manually picked out to a large extent. The size separation also resulted in flyers and other newsprint grade fibres falling through as “unders” into a less valuable mixed grade.

Overall findings are listed below.

Performance

Disk screens were found to be effective at separating fibre materials by size. Large pieces and bundles of cardboard were effectively separated as “overs” from the cardboard disk screens, and newsprint sheets were effectively separated as “overs” from the newsprint disk screens.

Disk screens were found to have limited ability to separate smaller sized “browns” (cardboard and boxboard) from newsprint - these still had to be sorted manually.

Disk screens were found to be capable of separating 15 tonnes per hour or more of fibres into two streams - the larger sized “overs” which were conveyed over the disks, and the smaller sized “unders” which fell through the disks to the conveyor below.

Disk screens were found to agitate and fluff newsprint fibres, making it more difficult to remove browns and contamination by post-screen sorters.

Disk screens were found to be adjustable (angle) to compensate for variations in the incoming fibres due to seasonal changes and weather conditions.

Disk screens were found to be affected by temperature and wetness conditions which required angle adjustments or other intervention to compensate.

Revenues

Disk screen systems were found to be capable of producing highly marketable grades of cardboard, newsprint and mixed papers when used in combination with manual sorters.

Disk screens were found to separate out smaller newsprint grade materials such as flyers, which fell through as "unders" into a less valuable mixed papers grade.

Costs

Operating costs of disk screen systems were found to be mainly the cost of power to operate the screens, and the cost of labour to manually sort browns and contamination from newsprint.

Costs (continued)

Maintenance costs of disk screens were found to be mainly the cost of labour to regularly clean the screens (typically once or twice daily) of plastic bags and other debris wrapped around the disks and shafts.

Disk screens generally appeared to be durable and may require only infrequent repairs or replacement of parts due to wear.

Capital costs for disk screen fibre sorting systems were found to be \$500,000 or more.

Disk screens were found to be readily adapted to conventional conveyor sorting systems for an additional cost in the order of \$100,000 per screen.

4. CONCLUSIONS

Compared to manual fibre sorting systems - using either tables or conveyors - disk screens had distinct advantages and disadvantages as summarized below.

Advantages

The main advantage of disk screens over manual systems is the ability to sort by size. Disk screens were clearly effective at separating fibres into three general sizes - large (cardboard rich), medium (newsprint rich) and small (mixed papers).

This feature, combined with the ability of each screen to quickly separate large quantities of fibres into “overs” and “unders”, may result in an efficient fibre sorting system

Disk screen systems appear to require fewer sorters than manual systems, and the ergonomics of the sorting activities may be better because the screens can remove large pieces of cardboard and other materials that are awkward to handle.

Disk screens appear to be generally durable and reliable, and may offer ongoing high performance with infrequent breakdowns.

Disadvantages

A disadvantage of disk screen systems compared to manual fibre sorting systems is the cost. Capital costs for disk screens are substantial but may be justified over a period of ten years or longer. Ongoing power costs and routine cleaning and maintenance are also important considerations.

Revenues from sale of materials processed using disk screen systems can be lower than manual systems because the screens tend to separate smaller materials into a less valuable mixed grade of paper that might otherwise be left in the newsprint stream.

Manual sorting requirements for disk screen systems - while possibly less than manual systems - were still substantial because of the limited ability of the screens to separate smaller pieces of cardboard and particularly boxboard from newsprint. Also, the fluffing of newsprint sheets made sorting more difficult after the screens, thereby tending to reduce labour savings.

5. RECOMMENDATIONS

The objective of this project was to study fibre sorting technologies and make recommendations regarding their application at materials recycling facilities in Ontario.

Disk screens have been recommended by suppliers as the state-of-the-art technology to sort fibres. They have been used in construction and industrial applications for years, and are now available for both fibre processing and single stream recycling applications.

Disk Screen Applications

Disk screen systems may have advantages in applications where large volumes of recyclables must be processed - more than 100 tonnes each day - making it possible to justify the higher capital, operating and maintenance costs.

High volume fibre recycling systems may be designed to take advantage of either the cardboard separator or the newsprint separator - or both types of disk screens - depending on the mix of incoming materials and the design objectives.

Disk screens may also be effective in applications where there is a mix of only two fibre materials. For example, if boxboard is collected separately on the recycling truck, the cardboard separator may be used to separate cardboard from newsprint with potentially low manual sorting requirements.

Disk screen systems may also be used for single stream recycling applications (Great Lakes Recycling in Detroit was an example of this) where containers must first be separated from fibres before being further processed by fibre disk screens.

Materials recycling facility operators must carefully weigh the added costs of disk screens and loss of market revenues against the benefits of reduced labour and higher throughput to determine which system is right for their application.

Appendix "A"

EQUIPMENT SUPPLIER INFORMATION

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An Expression of Interest was sent to equipment suppliers to obtain information on systems available to sort fibres. Four companies provided information on their disk screen systems, following which visits were made to facilities where their systems were installed.

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Bulk Handling Systems
CP Manufacturing
Machinex
Van Dyk Bollegraaf

Equipment supplier information is provided in this Appendix.

Please note: The information provided herein is **partial** only - the complete submission packages were not reproduced. The equipment suppliers may be contacted directly if additional information is needed.

Appendix "B"

SITE VISIT INFORMATION

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An Expression of Interest was sent to equipment suppliers to obtain information on systems available to sort fibres. Four companies provided information on their disk screen systems, following which visits were made to facilities where their systems were installed to sort newspapers, cardboard, boxboard and other household fibres:

<u>Facility</u>	<u>Location</u>	<u>Supplier</u>
Regional Waste Systems	Portland (Maine)	Bulk Handling Systems
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WRI	Ottawa	Machinex
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All four facilities used conveyor lines to move material - with disk screens installed at strategic points to sort desired fibres into “overs” (conveyed over the disks) and “unders”(fell through the disks to conveyor below). Manual sorters were used before and/or after each disk screen to pick out cardboard, boxboard and contamination. While systems varied, the fibres were typically processed in the following sequence:

Cardboard Disk Screen	- Overs conveyed to Cardboard bunker - Unders conveyed to Newsprint Disk Screen
Newsprint Disk Screen	- Overs conveyed to Newsprint bunker - Unders conveyed to Mixed Paper bunker

Site visit information is provided on the next page.

SITE VISIT INFORMATION

- Site 1: **Regional Waste Systems**
64 Blueberry Road
Portland, Maine 04102
- Contact: Eric Root, Director Materials Recycling
(207) 773-6465
- Materials: Residential fibres including cardboard, boxboard, newsprint, magazines,
phone books and other household papers.
- Equipment: **Bulk Handling Systems**
"Hi-Grader" newsprint separator.
-
- Site 2: **Great Lakes International Recycling**
30615 Groesbeck Highway,
Roseville, Michigan 48066
- Contact: Tony Joseph, Executive VP Marketing & International Sales
(810) 779-1310 ext 815
- Materials: Residential and Commercial single stream recyclables of various
containers and fibres.
- Equipment: **CP Manufacturing**
"Container/Paper" screen and "NEWScreen" newsprint separator.
-
- Site 3: **Waste Recycling Inc**
2811 Sheffield Road
Ottawa, Ontario K1B 3V8
- Contact: Peter McMahan, President
(613) 742-1222 ext 106
- Materials: Residential fibres including cardboard, boxboard, newsprint, magazines,
phone books and other household papers.
- Equipment: **Machinex**
"OCC Separator" and "MACH Two" newsprint separator.
-
- Site 4: **Canadian Waste Systems**
1126 Fewster Drive
Mississauga, Ontario L4W 2A4
- Contact: Jim Kent, Operations Manager
(905) 624-8353
- Materials: Residential fibres including cardboard, boxboard, newsprint, magazines,
phone books and other household papers.
- Equipment: **Van Dyk Bollegraaf**
"ONP Separator" newsprint separator.

Appendix "C"

EXPRESSIONS OF INTEREST

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An Expression of Interest was sent to equipment suppliers to obtain information on systems available to sort fibres. Four companies provided information on their disk screen systems, following which visits were made to facilities where their systems were installed:

Bulk Handling Systems

CP Manufacturing

Machinex

Van Dyk Bollegraaf

The Specifications for the Expression of Interest are provided on the next page.

REGIONAL MUNICIPALITY OF WATERLOO

EXPRESSION OF INTEREST 2000-06 FOR

FIBRE SORTING SYSTEMS

SPECIFICATIONS

The Region of Waterloo operates a Blue Box program where recyclable materials are collected from residential homes and buildings by recycling trucks and delivered to the Materials Recycling Centre (MRC) for processing and shipment to recycling markets.

The fibre materials - newsprint, cardboard and boxboard - are collected in one compartment of the truck and sorted at the MRC using a skid steer to load fibres onto tables where employees sort the three fibre streams by hand - a very labour-intensive process.

The Region is investigating if the purchase of systems or equipment that substantially reduce manual sorting requirements are more cost-effective for sorting fibres into their marketable components.

The fibre materials are currently collected and sorted into three streams as follows:

1. Newsprint - newspapers, inserts, magazines, phone books, paperbacks and household fine papers that are either loose, in plastic bags, or bundled together.
2. Boxboard - single-layered boxes (cereal, detergent, etc), egg cartons and tissue cores that are either loose, in plastic bags, or stuffed into an empty boxboard box.
3. Cardboard - corrugated cardboard boxes that are flattened and bundled with string.

If your company can supply such systems or equipment, please provide the following information:

- Complete description of how and what fibres can be sorted.
- Description of any manual sorting or other labour requirements.
- Performance specifications, space requirements, etc.
- Estimated cost to purchase and install the systems or equipment.
- Approximate operating and maintenance costs.
- List of references/locations currently using such systems.

Please contact Mike Ursu at (519) 883-5150 ext. 251 if you have questions of a technical nature.

Appendix "D"

LITERATURE SEARCH

Appendix "D"

LITERATURE SEARCH

A literature search was conducted to obtain up to date information on fibre sorting technologies.

Background

Paper and paperboard account for 40% by weight and 34% by volume of the municipal waste stream in the United States. Eighteen percent by weight consists of paper and paperboard packaging with a projected increase of an additional 2% by 2010². Paper fibre is clearly a dominant material in the municipal waste stream. The major exporting countries of paper products in order are: Canada, Finland, Sweden, the United States, and Germany. While 90 percent of countries produce paper products, the five major exporters account for 66% of the volume traded.

Canada is the leading exporter of newsprint supplying 49% of the total global demand¹. The Canadian Pulp and Paper Association reported in 1999 that Canadian mills converted 5.2 million tonnes of recovered paper into new paper, paper products and building materials. Forty two percent of all paper consumed by Canadians was recycled into newsprint products². Therefore the recovery of newsprint, and paper products in general, is a key component of provincial diversion goals and recycling programs.

There are more than 90 common grades of paper³ making the effective separation of recovered paper an important aspect of revenue maximization in MRF operations.

Disk screens have been widely used in the waste management industry since the mid 1970's. They typically consist of multiple horizontal shafts that parallel each other and are oriented perpendicular to the direction of the material flow. The shafts have a staggered arrangement of disks that form openings for undersized material to fall through. Gaps exist between the disks on adjacent shafts, as well as between the disks. The rotating shafts agitate the material while moving it along the screen. The materials to be separated, fall between the spaces and oversized materials are carried over the top of the disks.

Advantages of disk screens include better self-cleaning capability and ease of adjustment of disk spacing. Disk screens also offer a smaller foot print and are relatively inexpensive. Disadvantages include problems with wrapping of stringy contaminants around the shafts necessitating frequent shut down and clean up. The disks also require periodic replacement due to wear.

¹“Canada: Paper Recycling Machinery Market Report” Industry Sector Analysis.
July 16, 1998 World Reporter, DIALOG accession number 03144589.

²www.cppa.org Canadian Pulp and Paper Association

³“Recycled Paper Guidelines” 1996, U.S. EPA. Office of Solid Waste.

Appendix "D" (continued)

Vibrating screens are used in a variety of industrial applications. The screens are typically flat, inclined decks operating in either side to side, linear or vertical motion - essentially sifting the material. Side to side oscillating motion tends to gyrate material down the deck facilitating separation of the waste stream based on the respective weight of its components. Similarly, linear motion tends to move lighter materials up the deck. Vertical motion screens are generally used to separate out smaller contaminants by 'fluffing' the material. Vibrating screens come equipped with a variety of surfaces and are commonly used in combination to create a cascading effect.

Trommels or rotating-drum screens are widely used in the waste management industry, particularly in mixed MSW sorting applications. Material is generally gravity fed into the upper end of a large diameter drum rotating on an angled horizontal axis. The rotational motion of the drum agitates the material in conjunction with tines and metal bars, known as lifters, mounted on the interior of the drum. The tilt of the drum and speed of rotation controls the throughput and degree of separation. Separation of undersized material is achieved through the incorporation of screens and or series of holes in the sides of the trommel or drum.

Variations on these include **finger and star screens**. The tapered and slotted finger elements of finger screens offer a non-binding deck surface, potentially reducing clogging problems. Star screens consist of a series of rubber star-shaped disks that rotate in a pre-configured series. Cardboard bounces over the screens while paper is pulled downward through the rotating disks.

Approach

A literature search of DIALOG and the Internet was completed to secure up to date information on known and new fibre sorting technologies. Generally it is assumed that a single search engine covers approximately 16 % of the Internet. Ten separate search engines were therefore utilized to provide adequate subject coverage. Twelve DIALOG databases were also searched using a key word strategy reflective of the study objectives. Eight paper processors were interviewed to obtain their perspective on current industry trends.

New technologies were reviewed for possible broad industry application. Existing applications were reviewed to assess current levels of refinement and industry acceptance. Disk and star screens, trommels, vibrating screens, optical sorters and finger screens were considered.

Results

Air classification units were most commonly found in highly automated MRF's. Their primary purpose in these situations was to separate heavy and light fractions prior to the fibre sort. Magnetic and eddy current separators were also found in these operations to further prepare the fibre stream by removing potential contaminants.

Application of vibrating screens was found to be primarily limited to separation of recyclable containers from the fibre stream. Units such as Guelph's Ballistic Separator or Northumberland's

Appendix "D" (continued)

Single-Bounce Adhesion Separator represent local examples of these applications. Their advantages include the ability to separate materials into several sizes while not unduly 'fluffing' the material. Disadvantages include screen blinding and relatively high capital and maintenance costs.

Trommels and rotating drums are relatively common applications in paper sorting operations. They offer high throughput rates with relatively minimal maintenance. However screen blinding and insufficient sortation of paper grades is a common problem depending on the mix of materials being processed.

Disk screens tend to be used primarily to remove fines, grit and other small contaminants from sorted fibre streams, predominantly OCC.

One commercial paper processor was identified utilizing optical sorting technology⁴. Several other optical sorting systems are currently under development⁵. Issues with effective mechanical sortation of high burden depths and high initial capital cost appear to be the current limitations of this technology.

No screen system was found that eliminated the need for either a manual pre-sort or a post-mechanical manual sort. However, combinations of manual and modern mechanical sorting systems were, in general, found to be more efficient than entirely manual systems provided sufficient tonnage was being processed to warrant the initial capital expense.

For example, in two MRF's handling only paperstock, mechanical sortation increased processing speed from 0.5 tonnes of OCC mix/FTE/hr to approximately 4.5 tonnes of OCC mix/FTE/hr.⁶

⁴"MSS Paper Sorting System in Operation" 1999.
www.recyclingtoday.com/rtpub/july99/equipment0799.htm

⁵"Optical Sorters" Press Release. June 15, 1999. "High-Speed Automated Optical Paper Sorting System Now in Operation" www.paperloop.com

⁶"A tale of Two MRF's" by M. Phillips. Recycling Today. 1996.
www.recyclingtoday.com/rtpub/july96/fea3796.htm