



## INDUSTRIAL TECHNOLOGIES PROGRAM

# Mechatronic Design and Waste Paper Sorting System Control for Efficient Recycling

## Automatically Sorted Waste Paper Improves Efficiency of Paper Recycling Facilities

About 100 million tons of paper is consumed each year in the U.S., but only about 50 million tons are recovered to produce new paper. The closure of landfills and lack of waste-disposal facilities makes it difficult to handle the remainder of the waste paper without increasing recycling activities. The primary challenge of recycling paper involves meeting the high quality standards that are required of recycled products. Waste paper is generally mixed and it needs to be sorted into white ledger, coated, and other non-white grades. Mixed wastepaper grades are of very low value, even if they contain a large percentage of high-quality wastepaper. Currently, waste

paper sorting is a labor-intensive process in which workers manually sort paper into different paper grades based on recognition. In order to improve the economics and efficiency of paper recycling, researchers at North Carolina State University are developing a completely automated system to sort waste paper at commercially effective speeds.

If successful, an automatic, computerized method of characterizing waste paper will improve the quality of recycled fibers sent for further processing. The technology will also decrease energy costs and the cost of waste and water disposal for paper recycling plants.



*Pilot plant trials of stiffness sensor (static test shown on the left; dynamic test shown on the right).*



### Benefits for Our Industry and Our Nation

- Replaces manual sorting of waste paper
- Improves quality and homogeneity of recycled fibers
- Recycles a greater percentage of mixed waste paper than present rates
- Characterizes waste paper automatically
- Provides a quality check for buyers and sellers of waste paper
- Saves 32 trillion Btus of energy annually
- Decreases solid waste production by 66 million tons
- Conserves 22 billion gallons of waste water

### Applications in Our Nation's Industry

The automated sorting technology is applicable to 100 percent of the paper recycling market. It is expected to achieve a market share of 75 percent of the paper and board mills and recycling plants in this country. A lignin sensor developed by this project has been incorporated into a commercial recycling system to distinguish paper grades. This system is sold by MSS Inc.

## Project Description

**Goals:** To develop and understand an efficient, fast, accurate, and completely automated waste paper sorting system.

Researchers will apply the principles of mechatronic design to this problem (i.e., the fusion of mechanical engineering with electronic and intelligent computer control in the design and manufacturing of industrial products and processes).

The research will develop components to mechanically screen the waste paper, prepare the paper for image analysis, carry the paper past optical sensors, and separate the paper into different bins. Sorting will be conducted based on optical properties, including color identification using a multiple-object color tracking system to identify sample categories based on color.

## Pathways

There will be two phases to the research: (1) handling/moving the waste paper through a sorting system, and (2) detecting characteristics of the paper and identifying the type of waste paper.

## Progress and Milestones

The following milestones have been identified for reaching the objectives of this research:

- Designed robust industrially worthy lignin sensor (Completed June 2004)
- Developed color tracking system (Completed December 2004)
- Developed a decision-making algorithm (Completed December 2005)
- Evaluated sensing techniques for food packaging, waxed old corrugated cardboard (OCC), coated OCC, and high adhesive paper (Completed June 2006)
- Incorporate and test array of lignin/gloss/color sensors and decision-making algorithm

## Commercialization

The lignin sensor to distinguish paper grades has been incorporated into a commercial product by MSS, Inc. In addition, Advanced Sorting Technologies (AST) has agreed to test the sensors and decision-making algorithms in their pilot plant facilities. AST is uniquely capable of incorporating the new technology into existing automated sorting lines. A commercial matrix of lignin or stiffness sensors is estimated to cost \$20,000 with a payback time of 6 months.

## Project Partners

Department of Wood and Paper Science  
North Carolina State University  
Raleigh, NC

Advanced Sorting Technologies, LLC  
Nashville, TN

Weyerhaeuser Company  
Federal Way WA

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## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy  
**Energy Efficiency  
and Renewable Energy**

Bringing you a prosperous future where energy  
is clean, abundant, reliable, and affordable

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