Recycling Contamination

Challenge-Based Innovation: 2040 Projection

Michael Cavoli, Michael Celesti, Michelle Li, Andre Vigroux
May 13, 2016

THE OHIO STATE UNIVERSITY
INTEGRATED BUSINESS AND ENGINEERING

Michael Cavoli

Mechanical Engineering

Michael Celesti

Aerospace Engineering

Michelle Li

Finance

Andre Vigroux

Finance

Is this recyclable?

Is this recyclable?

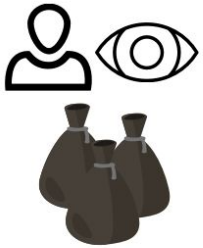
Is this recyclable?

73% of surveyed students incorrectly recycled these items

From a survey the team conducted in April 2016

Why is this a problem?

An institution's recycling process, 2016

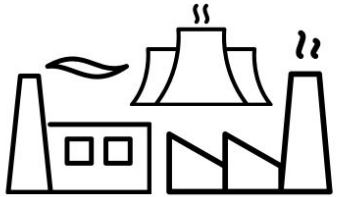


Start

You decide whether and how to recycle waste

Institution **pays** recycling plant to take recyclables

Employee visually judges **contamination**



Finish

Recycling plant sells **treated material** to manufacturers

Uncontaminated bags are processed at recycling plant

Macro drivers in the 2040 innovation environment

Climate change

Increased population growth

Increased urbanization

Technology improvements

What will most likely happen in 2040?

Uncertainty #1: Will people be educated and motivated about proper recycling practices?	**Uncertainty #2:** How will usage rates of reusable containers change?	**Key Implications**
People are more aware and educated, but not enough to eliminate recycling contamination	A slight increase in reusable containers	Demand for an innovative recycling bin will be necessary

How our product solves the job-to-be done

The job-to-be-done:

Autonomously sort waste items to reduce recycling contamination

Our solution:

- A smart waste management bin that sorts waste into its designated subcontainer
- Targeting large institutions such as airports, malls, and universities
- Bin systems are networked within a data integration system
- How we might apply CERN technologies:
  - CRISTAL
  - Materials sensors

Projected increase in value of recyclables increases future cost savings

2015

Scenario Savings - Percent Reduction of Contamination by Enterra Bin

Cost Savings - *5% Contamination Reduction*	$	274.50
% Cost Savings - *5% Contamination Reduction*		0.56%
Cost Savings - *10% Contamination Reduction*	$	549.00
% Cost Savings - *10% Contamination Reduction*		1.11%
Cost Savings - *20% Contamination Reduction*	$	1,098.00
% Cost Savings - *20% Contamination Reduction*		2.22%
Cost Savings - *50% Contamination Reduction*	$	2,745.00
% Cost Savings - *50% Contamination Reduction*		5.56%
Cost Savings - *100% Contamination Reduction*	$	5,490.00
% Cost Savings - *100% Contamination Reductio*		**11.11%**

Tipping fee per ton[1]

Garbage	$	45.00
Recycling	$	36.00

2040

Scenario Savings - Percent Reduction of Contamination by Enterra Bin

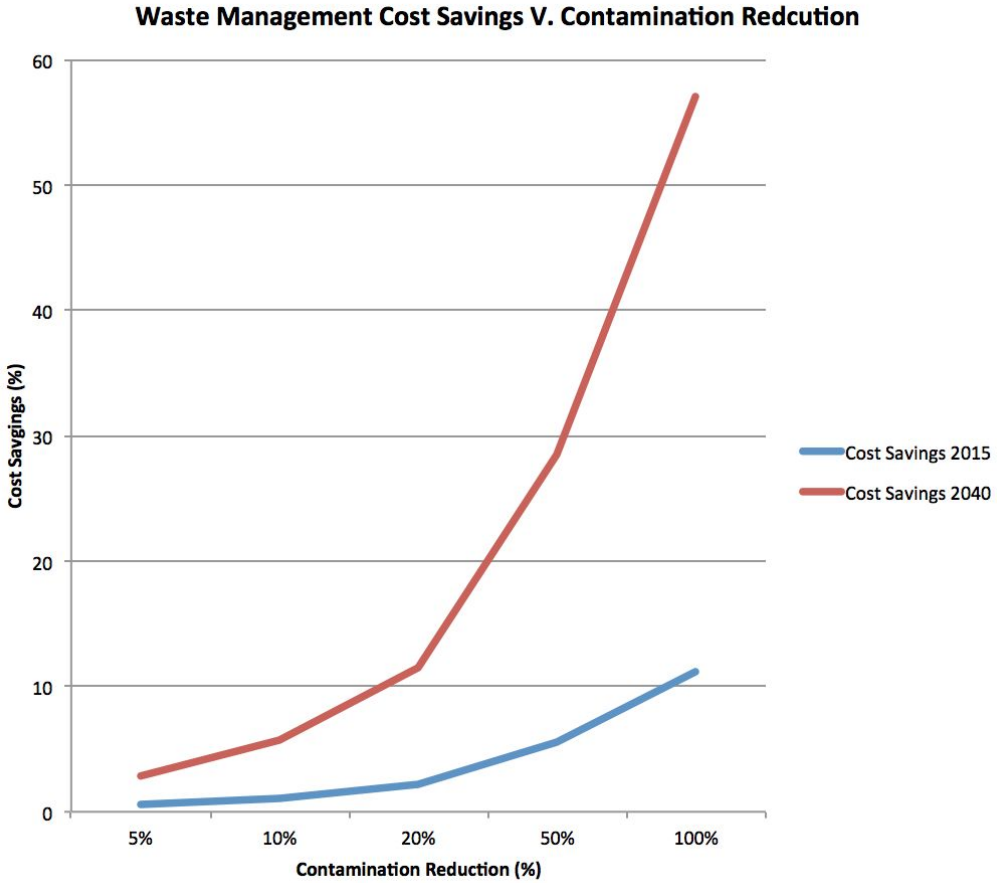
Cost Savings - *5% Contamination Reduction*	$	2,928.00
% Cost Savings - *5% Contamination Reduction*		2.86%
Cost Savings - *10% Contamination Reduction*	$	5,856.00
% Cost Savings - *10% Contamination Reduction*		5.71%
Cost Savings - *20% Contamination Reduction*	$	11,712.00
% Cost Savings - *20% Contamination Reduction*		11.43%
Cost Savings - *50% Contamination Reduction*	$	29,280.00
% Cost Savings - *50% Contamination Reduction*		28.57%
Cost Savings - *100% Contamination Reduction*	$	58,560.00
% Cost Savings - *100% Contamination Reductio*		**57.14%**

Tipping fee per ton[1]

Garbage	$	132.00
Recycling	$	36.00

In the past twenty years tipping fees have increased between $1.66 - $5.29 on a yearly basis (median is $3.50)

As garbage tipping fees increase over time, waste management cost savings increase



R&D strategy based on 2040 assumptions

Sensors will be widespread and less expensive

Certain types of waste will be more valuable

How expensive will it be to produce sensor-centered bins?	How important is it to determine whether something is recyclable?	Strategy
Technology will be more expensive than normal recycling bins	Users may be more educated and receptive to recycling, but a need for automatic sorting will still exist	Highlight improved processing power to provide substantial savings over several years of use

Sales & marketing strategy based on 2040 assumptions

Sensors will be widespread and less expensive
Large institutions will be the primary customer

What will be the level of profitability?	Will the primary market be concentrated or fragmented?	Strategy
12% profitability (Yahoo Finance)	Concentrated (larger institutions)	Provide custom delivery options for large orders

Manufacturing strategy based on 2040 assumptions

Sensors will be small enough to fit in a bin

Data collected from the bin networks create value for the customer

Will our manufacturing process meet demand?	How expensive is the manufacturing of the bin?	Strategy
Manufacturing speeds exceed demand	Slim to no profit on sale of the physical bins; main profit source from maintenance and data mining	Assemble-to-order manufacturing

Our solution

Smart Waste Bin

- One opening for any item
- Ring of optical sensors
- Divert waste into correct bin
- All bins connected via a network

Value Map

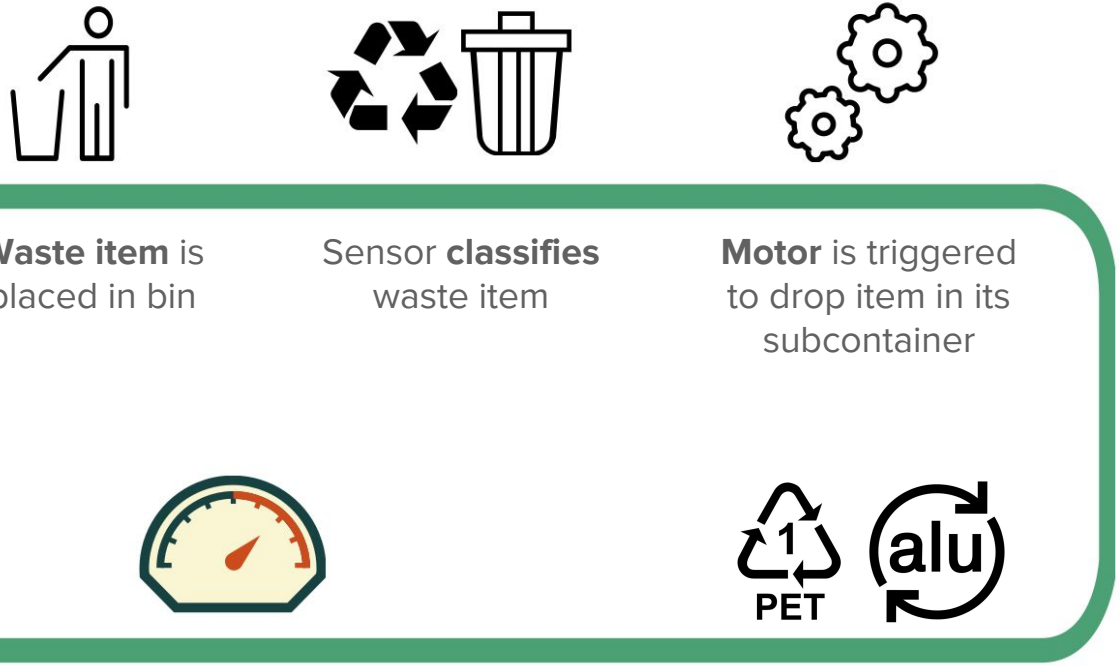
Cost Structure	Solution	Customer Acquistion
Activities	**Value Proposition**	**Relationships**
- Customer relations - Installation/Maintenance - Custom orders - Safety stock	-Provides significant cost and time savings -Valuable data -Collect material based on demand -Recycling companies (cut out middle man sorters)	- Airports, Hotels, Universities, Theme parks, Malls - Corporate buildings
Resources	**Pricing Strategy**	**Channels**
- Sensor tech - Regional service centers/warehouse - Educated service profesisonals	- Require annual waste by weight -Use cost analysis to measure savings specific to the customer and price accordingly -Sell units near production cost	- Direct sales -Website

Cost of production estimated to decrease in 2040

Technology	Cost (1990)	Cost (2015)	Optical Sensor Cost (2015)	Optical Sensor Cost (2040)
iPhone	$3,600,000.00	$300.00	$650,000.00	$54.17
3 Terabyte Hard Drive	$12,250,000.00	$85.00	$650,000.00	$4.51
8 GB RAM	$95,600.00	$64.00	$650,000.00	$435.15

Optical Sensor:	$160
Bin (3rd Party Man):	$50
Production Cost:	**$210**

Prototype demonstration



CRISTAL – Waste Management Software

File View General Recyclables Costs Options Window Help

Waste Composition – All Bins

Totals

Item	Percent	Weight (lb.)
Aluminum Cans	21.9	38,519
Misc Aluminum	0.7	1,231
Bi-metal cans	0	0
Ferrous	0	0
Non-ferrous	1	3,402
Magazines	0.7	962
Newspaper	5.3	8,091
Mixed Paper	9.8	14,220
Glass containers	6.4	7,984
PET	41.5	18,316
Rubber	0.5	867
Food Waste	10.2	17,278
Misc.	2	5,642
Total	**100**	**116,512**

Individual Bin Data

Bin 20

Receptacle	Type collected	% Full
1	Trash	62%
2	Aluminum	20%
3	PET	26%
4	Paper	95%

CHANGE

Prototype feedback and metrics

- Factors to test with target market
  - Speed
  - Simplicity
  - Accuracy
  - Process of changing bags
- Measuring an “encouraging” response
  - Easy to use
  - Easy to change bags
  - Less than 10% contamination (half of current contamination levels)

Steps from prototype to final product

- Have sensors for all materials
- Reconfigurable receptacles for regional needs
- Data integration with type of recyclables, mass, etc.
- Powered through outlet - 50 Wh/day

Wisconsin Recycling Data, 2013

Material	Market Value
Old corrugated cardboard (OCC)	$23,652,328.99
All other paper[1]	$22,942,318.76
Aluminum containers	$11,674,946.16
Steel (tin)/bimetal containers	$4,391,930.30
Glass containers	$575,525.45
Plastic #1 mixed	$2,251,147.71
Plastic #2 clear	$2,455,083.06
Plastic #2 colored	$1,178,330.22
Total	**$69,121,610.63**

Social impact: more than just saving time and money

Reflections

- With another two weeks:
  - Capacity sensors
  - Side door for changing bags
  - Aesthetics
- Biggest challenge this week:
  - Scenario Analysis / Strategy Tables
- Proudest achievements:
  - Cost Analysis
  - Prototype
  - Idea Generation
  - Team Dynamic
- What's missing?
  - Sensors
  - Knowledge of CRISTAL
- Additional opportunities:
  - Consumer bin model
- Helping Hand Award Nomination:
  - Power Team

Thank you

Appendices

Scenario Analysis

Predetermined 1:	Sensors will be ubiquitous and less expensive
Predetermined 2:	Climate change will decrease available space for waste

	Uncertainty #1: Whether people will be educated and motivated about proper recycling practices	Uncertainty #2: Change in usage of reusable containers (i.e. coffee mug, personal water bottle)	Scenario summary: key issues and business implications
Big Change	Nearly everyone understands what is recyclable and wants to recycle, and therefore there is little issue with recyclables in landfills and contaminated batches	Most individuals are using reusable containers for personal use	Lowest Product Opportunity, no value behind sorting bin so we will pivot to either producing cheaper bins and better logistics for recylcing or focus on industrial or medical recycling
Small Change	Poor education about what is and isn't recyclable and the lack of effort to recylce remains the same	Consumers still primarily prefer single use, dispoable containers	Greatest Product Opportunity, creative innovative sorting bin
Most Likely	More people are aware/educated yet there is still a lack of awareness and willingness to recycle	A slight increase in reusable containers	Most likely people will continue to not be motivated about recycling and demand for a new innovative bin will be necessary

Business Strategy - R&D

Strategic Given 1	Sensors will be less expensive and ubiquitous
Strategic Given 2	Certain types of waste will become more valuable

	How expensive will it be to produce sensor centered bins?	**How important is it to determine whether something is recyclable?**	**Strategic Options**
Threat Scenario	The sensors and network technology are too expensive to offset the economic benefits from improved recycling processing	Users are mostly aware of what is and is not recyclable, so a seperation system is unneccesary	Create a bin with less sophisticated sensor technology that only targets what trash is currently contaminating recyclables
Best Scenario	Bin is cheap to produce and maintain, which allows customers to gain large economic value from reduced recycling contamination	Users are not educated on what is able to be recycled, so a seperation system provides economic benefit	Create a bin that is able to effectively sort waste and produces high savings for institutions due to low implementation costs and reduced contamination
Most Likely Scenario	The technology needed for the bin is not as cheap as a normal recycling bin, but the improved processing will return substantial savings for institutions over several years or more of use	Users may be more educated and receptive to recylcing, but the majority will not become any more proactive and automated sorting will be necessary	Bin is capable of sensing most recyclable material, and can provide economic benefit from extensive use.

Business Strategy - Sales/Marketing

Strategic Given 1	Large institutions will continue to be the primary customer
Strategic Given 2	Sensors will be less expensive and ubiquitous

	What will be the level of profitablilty?	**Will the primary market be concentrated or fragmented?**	**Strategic Options**
Threat Scenario	< 5% Profitability	Fragmented, small businesses or households	Create a low-cost product with only a few sensing features maximizing recycling value (i.e. only sensing aluminum waste). Identify standardized retail options.
Best Scenario	>12% probability (typical) (Yahoo Finance)	Market will be split between concentrated institutions (whole system) and fragmented individual household units (one bin)	With such a large customer base we can create our own distribution channels
Most Likely Scenario	~ 8% Profitability	The primary market will be mostly larger institutions with smaller portion of sales from households	Custom delivery options for large orders. Less expensive models will be available at retail stores.

Business Strategy - Manufacturing

Strategic Given 1	Sensors will be less expensive and small enough to fit in the bin
Strategic Given 2	The data collected in the bin has value to the customers

	Will our manufacturing process meet demand?	**How expensive is the maufacturing of the physical bin?**	**Strategic Options**
Threat Scenario	Manufacturing would not be able to keep up with demand	Profit would only be gained through maintenance, marketing and data mining	Invest in more efficient manufacturing to try to lower costs
Best Scenario	Manufacturing speeds match demand	Profit would be gained through sale of physical bin and through maintenance, marketing and data mining	Maintain current manufacturing and offer more value-adding features at the same price
Most Likely Scenario	Manufacturing speeds exceed demand	Slim to no profit on sale of physical bin; profit on maintenance, marketing and data mining	Make manufacturing more reactive, implement more of a make-to-order policy, add value-adding features depending on profit