Memorandum
MONTEREY REGIONAL WASTE MANAGEMENT DISTRICT

Reviewed by: /PKS/ Date: 1-17-20
For General Manager

DATE: January 17, 2020

TO: General Manager

FROM: Director of Operations

SUBJECT: Residential Single Stream Fiber & Recovery Equipment Upgrades

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RECOMMENDATION: That the Board authorize the General Manager to negotiate and approve execution of a purchase agreement with Bulk Handling Systems (BHS) of Eugene, OR, for the purchase of Residential Single Stream Fiber & Recovery Equipment Upgrades in an amount not to exceed $3.5 Million (excluding Sales Tax estimated at $168,310).

BACKGROUND

The District's Materials Recovery Facility (MRF) 2.0 has been in operation for approximately two (2) years to process the incoming flow of Single Stream Recyclable materials (SSR) which were initially planned at approximately 15,000 tons per year and were actually 63,500 tons in 2019.

With the implementation of the National Sword initiative by the government of China in early 2018, the monetary value of post-processed recyclable commodities has declined by approximately 50% below what was anticipated for the MRF when the facility was designed. The National Sword initiative has reset quality standards for marketed materials not only in China, but in markets around the world. This has required that additional sorting staff be added to the processing lines to achieve those new standards, increasing labor costs above the original operating proforma that was established during the 2014 facility design. Additionally, the system was initially designed primarily to process Municipal Solid Waste (MSW) materials with the intention of meeting the California 75% diversion goals for all waste materials. It was not designed to most efficiently and effectively process single stream recyclables in the volumes now being received by the District. The Residential Single Stream Fiber and Recovery Equipment Upgrade that staff is proposing to implement is intended to begin to address some of the needs to process SSR materials to meet changing marketplace requirements, while improving the economic performance of the MRF. At the December Board meeting, staff presented that the MRF is projected to miss the FY19/20 budgeted revenues for the facility by approximately $1.4 million by the end of the fiscal year. Once implemented, these proposed investments would offset nearly two-thirds of this financial shortfall amount, or roughly $950,000, through a combination of revenue enhancements and labor cost savings. The remainder would be recovered next year as GreenWaste Recovery begins to pay for the full share of the SSR Processing Fees (approximately $550,000).

DISCUSSION

Currently Budgeted Investments. In the FY 19/20 Budget, staff had included the purchase of a Cardboard Separation Screen to be installed into the facility, which would improve the recovery of Cardboard (Old Corrugated Containers, aka OCC), while eliminating four (4) temporary labor positions that the District has been utilizing for the separation of this material. Without the purchase of this equipment, the District would need to convert those temporary positions to full time positions. The following Table illustrates the cost of the equipment, the related labor offsets, the anticipated increase in annual maintenance expenses for this system (estimated as 2.5% of equipment purchase cost), and the estimated payback period for the investment.

	OCC Screen				
			Cost	$ 953,959.00	
Cost of Sorter / Year	$ 63,212.89				
Sorters Reduced	**4.00**				
Annual Savings	$ 252,851.54				
			Annual Savings in Labor	$ 252,851.54	
			Additional Maintenance Expense	$ 23,848.98	2.5%
			Payback of Investment - Years	4.17	

Unbudgeted Investments. Staff is proposing the purchase and installation of two unbudgeted equipment packages that are in addition to the budgeted OCC screen.

The first is a Fiber Optical Sorting (FOS) system. This equipment is conceptually similar in nature to the existing Optical Sorting systems that the system uses for the separation of various plastic materials. The FOS system also utilizes software to optically detect various fiber types and would then trigger air-jets to separate OCC and other brown-grade fibers (e.g., cereal boxes or similar) from newspaper and junk-mail. This further separation of the fiber stream would enable the District to increase the recovery of OCC materials from what is currently being shipped to market as Mixed Paper. This OCC material includes the smaller pieces of carboard that will not be captured with the OCC screen. There is more and more of this smaller carboard in the waste stream as consumers move to a larger percentage of their purchases coming through on-line sales. By capturing this material as OCC instead of Mixed Paper, the District will receive on average of $60/ton increase in revenue for every ton diverted. In addition, it improves the quality of the remaining materials that were previously being shipped as Mixed Paper into a Fiber grade called Residential Sorted Paper (RSP), which has an increased monetary value of roughly $25/ton. The Table below illustrates the cost of the equipment, the estimated additional recovery of OCC and its increase in value, the increased in the value of the remaining RSP, the anticipated annual maintenance expenses (estimated at 2.5% of equipment purchase cost), and the estimated payback period for the investment.

	Optical Fiber Sorter			
		Cost	$ 1,478,071.00	
Mixed Paper Tons Shipped/Yr	11,703.24			
Percentage OCC	35%			
Additional OCC Recovery/Yr	4,096.13	Residential Sorted Paper/Yr		7,607.11
Additional Value/ton OCC	$ 60.00	Additional Value per ton of RSP		$ 25.00
Additional Revenue of OCC / Yr	$ 245,768.04	Additional Revenue of RSP / Yr		$ 190,177.65
		Annual Additional Revenue	$ 435,945.69	
		Projected Annual Additional Maintenance Expense	$ 36,951.78	2.5%
		Payback of Investment - Years	3.70	

The second recommended purchase is a Residual Line Robotics recovery system. The District commissioned SCS Engineers to conduct a Recycling Waste Characterization study of the SSR processing residual materials (e.g., those materials that are not being captured by the current system). This is similar to the study that was conducted in July that characterized the incoming SSR materials. One of the more informative pieces of information that this study of the SSR processing residual materials provided was that significant value and amounts of Container Redemption Value (CRV) materials were not being captured throughout the process, most specifically through some of the mechanical separation devices used in the system. The following Table applies the percentages of various CRV categories defined by the characterization study to estimate the monetary value of CRV materials present in the SSR processing residuals.

			CRV Value Available for Recovery		
	Total Tons Processed /Yr	% of SSR Residual	Tons of CRV in Residual	Value of Lost CRV in Residual	% of Lost CRV Value
Alum	60000	0.06%	36.81	$ 141,730.39	16.70%
PET	60000	0.18%	108.84	$ 163,258.05	11.42%
HDPE	60000	0.26%	155.26	$ 62,102.08	12.51%
PP	60000	0.18%	107.24	$ 42,895.25	25.41%
Glass	60000	0.37%	220.35	$ 11,017.25	26.86%
		1.05%	628.49	$ 421,003.02	
			Lost Value Per Year	**$ 421,003.02**	

Staff would like to install a robotic recovery system along a section of the residual stream to recover at least 70% of this material. Although this will not significantly increase the recovery/diversion rates of the overall system (1%), it would increase the total CRV revenue generated by the system by close to 10%, which represents roughly $3 million a year.

This would be the first Robotic system installed in the facility. In the long-term operations of this and most other MRF's, Robotics are increasingly utilized in a variety of sorting operations throughout the facility. Over the next few years, staff anticipates coming back to the Board with additional proposals for the implementation and installations of Robotics to reduce Workers Compensation and CalPERS, and to increase efficiencies and cost-effectiveness of the operations. Installation of Robotics would begin that process and give the operations and maintenance teams firsthand experience with these next generation pieces of equipment to become familiar with their capabilities as well as their technical and operational requirements. The Table below includes the cost of the equipment, the estimated value of the CRV recovered through this system, the labor cost savings provided, the anticipated annual maintenance expenses (2.5% of equipment purchase cost), and the anticipated payback period for the investment.

Partial Residual Line Robotics			
Cost	$	1,371,611.00	
Annual CVR Marterial Lost per Year	$	421,003.02	
Expected Percentage Recovered		70%	
Additional CRV Recovery Value per Year	$	294,702.12	
Average Cost of Sorter 1 / Year	$	63,212.89	
Number of Sorter 1 Replaced		1.00	
Annual Savings in Labor	$	63,212.89	
Total Annual Financial Benefit	$	357,915.00	
Projected Annual Additional Maintenance Expense	$	34,290.28	2.5%
Payback of Investment - Years		4.24	

FINANCIAL IMPACT

The three separate system improvements presented above are anticipated to provide approximately $730,000 in additional revenues, and to offer an additional $315,000 of labor savings per year. Please note that the costs listed above for each of the individual investments exceeds the requested authorization of $3.5 Million. However, the three elements were quoted as stand-alone installations, each requiring their own mobilization and project management expenses. Combining each of these elements into a single project results in a savings and yields the proposed $3.5 million not-to-exceed amount. With those combined savings/efficiencies for the cost of this upgrade project, the estimated payback on the investments could be realized in less than 4 years. The following Table anticipates the investment savings of the combined systems procurement, the anticipated revenue enhancements of each system, any labor cost savings, and includes the anticipated payback period of the combined investments.

Combined System Financial Impact			
Cost	$	3,500,000.00	
Annual Additional Revenue	$	730,647.81	
Annual Savings in Labor	$	316,064.43	
Projected Annual Additional Maintenance Expense	$	87,500.00	2.5%
Payback of Investment - Years		3.65	

The FY 19/20 budget currently includes $876,000 for the capital proposed for this project (in OCC Screen and Lock-Out-Tag-Out Optimization line items). Staff recommends reallocating the MRF 2.5 Concept Design work and the balance of the Fall Protection line items ($125,000 + $100,000). Staff proposes utilizing/diverting the allocation of $2 million from the Compost Site capital improvement line item, which is being postponed until next fiscal year. Staff also recommends deferring the purchase of the Volvo excavator to FY 20/21 ($300,000). The balance of the capital funds needed will come from the Capital Improvement budget for the Last Chance Mercantile building ($100,000), which still needs the final scope to be designed.

Staff recognizes that the deferments of some of these capital expenditures does not lessen the long-term capital needs of the District. However, staff does see that the short-term use of this capital to gain revenues and reduce costs, with a 4 year payback timeline, does provide long-term improvements in the financial operations of the District and position it to generate more revenues to meet future needs beyond that time horizon.

CONCLUSION

It is therefore recommended that the Board authorize the General Manager to negotiate and approve execution of a contract with Bulk Handling Systems (BHS) of Eugene, OR, for the purchase of Residential Single Stream Fiber & Recovery Equipment Upgrade in an amount not to exceed $3.5 Million (excluding Sales Tax estimated at $168,310) for the long-term functionality and financial performance of the Single Stream Recyclables processing capacities and capabilities of the MRF. Please note that staff intends to pursue a Sales Tax Exemption request for Recycling Equipment in accordance with a State of California program. The scope of the BHS contract is for the design, fabrication, delivery, installation, and commissioning and startup of the equipment. The attached Table 1 presents the preliminary equipment list that is anticipated for this project.

Tim Brownell
Director of Operations

ATTACHMENT: Table 1 – Preliminary Order List

TABLE 1 - Preliminary Order List

Equipment Detail

January 16, 2020

Item #	Model #	Description	Width	Length	HP	Quantity
Equipment						
C001	LPS-72	OCC Separator Unders Collection Conveyor - By BHS Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Large Transfer Duty Impact Zone	72"	34'	3	1
C002	LPS-60	OCC Separator Unders Transfer Conveyor #1 - By BHS Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Large Transfer Duty Impact Zone Conveyor Hopper	60"	20'	3	1
C003	LPS-54	OCC Separator Unders Transfer Conveyor #2 - By BHS Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Large	54"	32'	3	1
C101	LPS-72	Fiber Optical Infeed Conveyor Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Large Reversing Conveyor	72"	12'	3	1
C102	ACL-108	Browns Optical Accl Conveyor Conveyor Type: Acceleration Support Bents Skirt Walls	108"	18'	10	1
C103	LDP-30	Browns Optical Ejects Collection Conveyor Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Small Reversing Conveyor	30"	24'	3	1
C104	LDP-30	Browns Optical Defaults Collection Conveyor Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Small Reversing Conveyor	30"	24'	3	1
C105	LPS-36	Browns Optical Ejects Incline Conveyor Conveyor Type: Sliderbed Support Bents Skirt Walls Conveyor Chute Small Transfer Duty Impact Zone Conveyor Hopper	36"	28'	3	1

TABLE 1 - Preliminary Order List

Equipment Detail

January 16, 2020

Item #	Model #	Description	Width	Length	HP	Quantity
C106	LPS-60	Fiber QC Infeed Conveyor	60"	114'	10	1
		Conveyor Type: Sliderbed				
		Support Bents				
		Gravity Take Up				
		Skirt Walls				
		Conveyor Chute Large				
		Conveyor Bend				
		Conveyor Under Skirting				
		Reversing Conveyor				
		Emergency Pull Cord				
C107	LPS-30	Browns QC Transfer Conveyor	30"	15'	3	1
		Conveyor Type: Sliderbed				
		Support Bents				
		Skirt Walls				
		Conveyor Chute Small				
		Reversing Conveyor				
C201	LPS-30	Recovery QC Sort Conveyor	30"	60'	5	1
		Conveyor Type: Sliderbed				
		Support Bents				
		Skirt Walls				
		Conveyor Chute Small				
		Conveyor Bend				
		Conveyor Hopper				
		Conveyor Under Skirting				
		Emergency Pull Cord				
		Post Sort Conveyor End Enclosure				
C202	LPS-18	Recovery QC Containers Return Conveyor	18"	42'	2	1
		Conveyor Type: Sliderbed				
		Support Bents				
		Skirt Walls				
		Conveyor Chute Small				
		Reversing Conveyor				
E001	DRS98-11-10-762	BHS OCC Separator® - By BHS	98"		7.5,7.5	1
	OCCOC	OCC Overs Chute				1
	OCCUCTD	OCC Unders Chute				1
R102	CR-LPS-36	Existing Fiber Optical Defaults Collection Conveyor - Modified	36"	25'		1
		Support Bents				
		Conveyor Chute Small				
R104	CR-LPS-54	Existing Fiber QC Conveyor - Modified	54"			1
R106	CR-LPS-48	Existing Fiber QC Infeed Conveyor - Removed	48"			1
R201	CR-LPS-36	Existing PS #2 Overs Reversing Conveyor - Modified	36"	39'		1
		Retro Work Shorten				
		Support Bents				
R202	CR-LPS-36	PS #2 Overs Transfer Conveyor	36"	18'		1
		Support Bents				
R203	CR-LPS-30	Existing 3rd Sort Collection Conveyor - Modified	30"	61'		1
		Conveyor Type: LPS-30				
		Conveyor Length Addition				17
		Support Bents				

TABLE 1 - Preliminary Order List

Equipment Detail

January 16, 2020

Item #	Model #	Description	Width	Length	HP	Quantity
R204	CR-LPS-30	Existing Containers Collection Conveyor - Modified	30"	62'		1
		Conveyor Type: LPS-30				
		Conveyor Length Addition				4
		Support Bents				
		Conveyor Bend				
BR001	HDS-60	Existing 12 In+ Presort Conveyor - Modified - By Customer	60"	73'		1
BR003	HDS-60	Existing 12 In+ Presort Takeaway Conveyor - Modified - By Customer	60"	25'		1
BR201	HDS-36	Existing Ferrous Takeaway Conv Conveyor - Removed - By Customer	36"			1
BR202	HDSC-48	Existing Ferrous Return Conveyor - Removed - By Customer	48"			1
BR203	MTP 160 Q 100	Existing Magnet #1 - Removed - By Customer				1
BR204	CHUTE	Existing Magnet Chute #1 - Removed - By Customer				1
BR205	MTP 160 Q 100	Existing Magnet #2 - Removed - By Customer				1
BR206	CHUTE	Existing Magnet Chute #2 - Removed - By Customer				1
E101	ColorPlus108R	NRT Colorplus™ Browns Optical	108"		0.5	1
	CHUTE	Optical Chute				1
E102	ACR-108	Browns Optical Air Curtain				1
E103	AIR-350	Air Compressor				1
		Air Compressors PKG Model No: AIR-350				
		AC PKG Description: Air Compressor System 350CFM KAE-345CSD75-SYS				
		AC Pkg Tank Size: Dry Tank 1550 Gallon				
		Air Piping: Included				
		Air Compressor Qty Base Package				1
		Air Compressor Base Package Total HP				75
E201	AQC-1	Max-AI™® Autonomous Recovery QC				1
E203	AQC-1	Max-AI™® Autonomous Recovery QC				1

Item #	Model #	Description	Width	Length	HP	Quantity
Structure						
R001	ST-MAG-SS	Existing Postsort Access Walkway - Modified - By BHS				1
		Walkway				
		Caged Ladders				
R002	STPLAT-MISC	Existing Screen & QC Access Walkway - Modified - By BHS				1
R101	STRET	Existing Optical Maintenance Platform - Modified				1
R103	STRET	Existing Container Line Access Walkway - Modified				1
		Walkway				
S001	PLAT-EQUIP	OCC Maintenance Platform - By BHS				1
		Platform Square Footage				210
		Caged Ladders				
S101	ST-MAG-SS	Browns Optical Support Structure				1
S201	PLAT-EQUIP	Recovery QC Platform				1
		Platform Square Footage				130
		Standard Landing Stairs				
		Throw Chute 24" x 24" Qty				6

Rapid adoption

This article originally appeared in the August 2019 issue of Resource Recycling.
by Jared Paben

Over just a few years, robotic sorting has gone from a gee-whiz laboratory curiosity to a key technology in North America's newer and more advanced sorting facilities.

In late June, for instance, AMP Robotics unveiled the installation of six of its robots at the Single Stream Recyclers (SSR) MRF in Sarasota, Fla and noted SSR planned to install another four dual-robot systems this summer. In May, Bulk Handling Systems (BHS) sold two of its MAX-AI AQC-4 units, each with four sorting arms, to a PET recycling plant. And Plessisville, Quebec-based recycling equipment provider Machinex announced in late April that its SamurAI technology has been deployed in partnership with AMP at a Quebec MRF.

What's more, Waste Management, North America's largest MRF operator, in late May revealed that it's testing robots from three different providers at its facilities.

A comprehensive analysis by Resource Recycling concludes at least 88 artificial intelligence recycling units are either working or have been purchased in the U.S. and Canada. They're sorting residential and commercial recyclables, mixed waste, plastics, shredded electronics, and construction and demolition debris (C&D).

They are proving to be central to pulling operators through a variety of pressures, such as staffing challenges and material quality demands, that are expected to persist in the years ahead.

Showing up across the continent

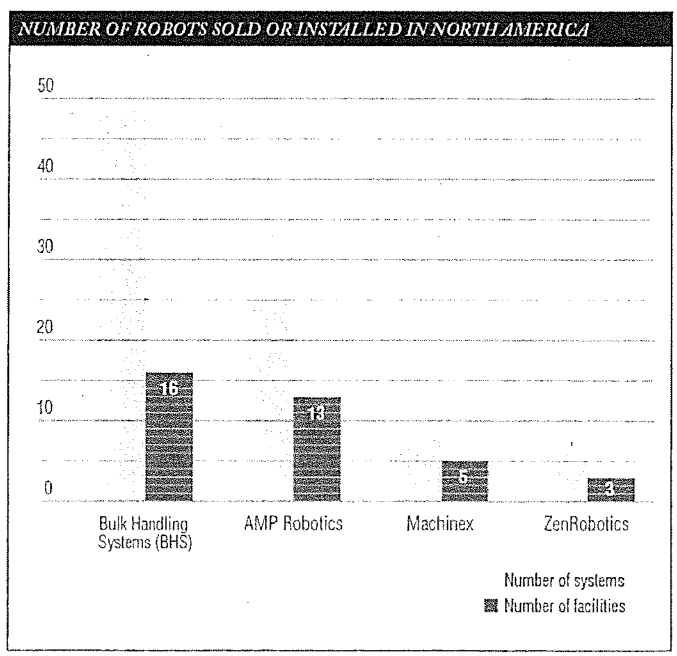
The first known sorting robot to work in a U.S. recycling facility was installed only three years ago. That's when fledgling AMP Robotics installed and tested its robot at Alpine Waste & Recycling's Altogether MRF near Denver. Since then, other facilities have been quick to adopt the technology.

Resource Recycling compiled data from major players in the North American robots business: AMP, BHS, Machinex and ZenRobotics, and we supplemented the data with information obtained from news sources and past reports.

AMP, BHS and ZenRobotics all have units installed overseas – in Europe, Asia and Australia. This article's analysis, however, considered only those installed in the U.S. and Canada.

Here are a few takeaways:

The technology is focused on curbside recyclables: For the most part, robots are working in single-stream MRFs. At least 39 facilities in the U.S. and Canada have robots.



Sources: Bulk Handling Systems, AMP Robotics, Machinex, ZenRobotics and news reports.

Note: The numbers above count visioning systems, including those deployed on a standalone basis or integrated with sorting equipment.

Of those 39 sites, 19 are single-stream MRFs, three are mixed-waste processing sites, two are electronics processors, two are PET recyclers and two are facilities focused on C&D materials. Manufacturers would not disclose the types of streams being handled by the remaining 11 locations using robotics.

BHS has the most systems deployed: The numbers sold and set up by each company are somewhat difficult to pinpoint because installations and contract signings are ongoing. Nevertheless, we were able to develop a conservative estimate of the number of systems that have been sold or deployed in U.S. and Canadian facilities. The details are shown in the chart above.

They're all over the continent, but they especially like sunny weather: Looking at geography, the robots have been installed in 15 states and three provinces. Nearly one-third are in California, which is perhaps not surprising given the state's sheer size, as well as policies encouraging materials diversion. See the table below for a complete rundown.

Robot providers have seen steady growth in terms of customer adoption over the past two years.

BHS announced in April 2017 that it had installed its first robot, at the Athens Services mixed-waste processing facility in Los Angeles. Now, a little over two years later, the company has sold or deployed over four dozen systems in the U.S.

It was only in mid-2018 that AMP Robotics' system hit certain milestones for performance and reliability that gave it the confidence to go to market in a bigger way, AMP founder Matanya Horowitz said. Today, AMP has sold or installed more than two dozen systems around the country.

Also in 2018, Machinex announced a partnership with AMP through which the companies sell SamurAI robots. Today, eight SamurAIs have been installed, mostly in Canada.

Finally, in fall 2016, Finland-based ZenRobotics announced it had installed its first robot at a U.S. facility: Recon Services/973 Materials, a C&D sorting facility in Austin, Texas. ZenRobotics now has six visioning systems connected to 11 sorting arms in operation around the U.S.

And new players are still looking to break into the business. In March, Sustainable Development Technology Canada (SDTC) announced a 1.4 million Canadian dollar (nearly $1.1 million U.S.) investment in Waste Robotics, a Québec robotic sorting startup.

State or province	Number of units	Company distribution
British Columbia	1	AMP Robotics
California	28	25 BHS 2 AMP Robotics 1 ZenRobotics
Colorado	1	AMP Robotics
Delaware	1	BHS
Florida	10	AMP Robotics
Illinois	1	1 Machinex/AMP partnership
Indiana	2	AMP Robotics
Michigan	2	AMP Robotics
Minnesota	3	AMP Robotics
Nebraska	1	AMP Robotics
Ontario	6	Machinex/AMP partnership
Oregon	2	BHS
Pennsylvania	8	BHS
Quebec	1	Machinex/AMP partnership
South Carolina	9	BHS
Texas	2	1 BHS 1 ZenRobotics
Virginia	2	AMP Robotics
Wisconsin	4	3 BHS 1 AMP Robotics

Note: The numbers above count visioning systems. Also, the table excludes an additional four ZenRobotics units because their locations weren't disclosed.

Chris Hawn, CEO of Machinex Technologies (a division of Quebec-based Machinex Industries), said he's been pleased overall with the adoption of robots in North America. "As long as you never over-promise and underperform, the end result will be that the machines continue to grow in acceptance and will only get better with time," he said.

Factors behind the trend

The adoption by the recycling industry has come for two key reasons: persistent staffing challenges and difficult markets requiring lower processing costs and better bale quality. Also, robots aren't prohibitively expensive, compared with some other advanced sorting equipment.

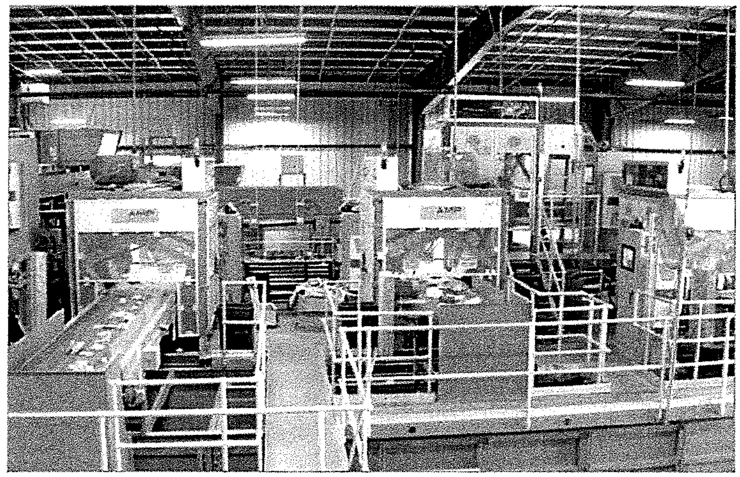
The first MRF to install a SamurAI robot was Lakeshore Recycling Systems' Chicago-area Heartland Recycling Center, which brought on the technology in May 2018. At the time, CEO Alan Handley noted difficult fiber markets prompted the move, but he also emphasized the benefits of reducing human sorters.

Manual sorting has long been tied to staffing issues, including difficulty finding people, injuries requiring time off, and employee no-shows on any given day. The challenges are exacerbated by low unemployment rates in the current economy.

Horowitz of AMP said customers tell him that production costs and labor issues are the biggest challenges the AMP units address, he said. China's restrictions on recyclables imports had ripple effects lowering commodities prices, he said, and a lot of people recognize robots and automation as a way to address that.

Hawn of Machinex noted sorting robots also bring other benefits in the areas of safety, separation reliability and, ultimately, optimization.

As noted earlier, Waste Management is starting to incorporate robots in its MRFs, with company leaders citing reduced labor costs, the ability to positively sort specific materials, and cleaner overall bales as benefits of using robots. The company has been testing a robot at a Houston-area MRF and is also using one at its Germantown, Wis. facility. And it plans to use a robot in a large, tech-heavy facility under construction in Chicago. During an investors summit in May, Waste Management executives said the company is testing robots at four MRFs, noting the units come from three different providers.



AMP Robotics installed six sortation units at the Single Stream Recyclers facility in Florida earlier this year. Four more are planned for the MRF.

The benefits and costs of these systems were illustrated in the Pacific Northwest recently.

In December, Pioneer Recycling Services was awarded a grant of $284,000 from Portland, Ore.-area regional government Metro to help it incorporate robotics, and the company matched that sum.

The project involves installing two BHS robots at Pioneer's Clackamas, Ore. MRF to sort materials on the container line. According to the company's grant application, Pioneer plans to reduce four manual sorting positions by attrition. "If successful, the robots will make more picks of their target and prioritized commodities than a human sorter can accomplish," according to the 2018 grant application.

The grant document notes the BHS MAX-AI AQC-1 units each cost $200,000. That does not include installation, freight, electrical and other costs, which, in Pioneer's case, totalled about $169,000.

A newer facility can often have lower installation costs, MRF experts have noted.

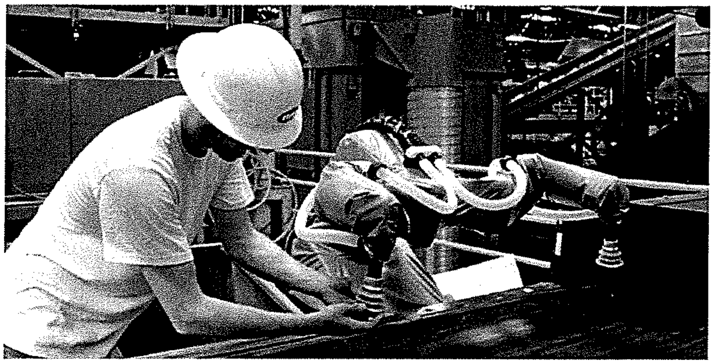
Ongoing evolution

As fast as the robots are being sold and installed, the technology and its applications are also quickly changing.

Recycling robots started as visioning systems connected to mechanical arms that use suction or a gripper to pluck items off the belt and drop them in a chute. While that's still essentially what most of them do, some MRFs are now using visioning systems independent of mechanical sorting arms. AMP calls its vision framework Neuron, and BHS calls its system VIS (short for "visual identification system").

Horowitz explained the visioning system can help facilities conduct waste characterization studies for less cost than bringing in an audit crew to break bales, separate items and weigh materials. They also provide key operations feedback, he noted, including warnings of surges or a dearth of material on the line.

Rich Reardon of Eugene, Ore.-based BHS said his company has customers using VIS to meet their contractual audit obligations. Even if a human-powered audit is conducted quarterly, it can't provide the kind of accurate picture of a materials stream on an ongoing basis that a visioning system can, said Reardon, who is vice president of sales and marketing for BHS.



The BHS CoBot is a newer offering designed to be used beside human sorters.

One plant in Norway is even using a BHS visioning system to examine fiber on its way to a bunker before it's baled. "They're the only company I'm aware of that'll know exactly what's going into their bale before they bale it," Reardon said.

AMP and BHS have both also worked to boost the sorting capacity of their products.

In May, AMP announced the release of its AMP Cortex dual-robot system (DRS), which uses two arms with a combined capability of 160 picks per minute. The company says the system is ideally suited for helping MRFs tackle fiber streams.

Earlier, BHS had developed MAX-AI Autonomous Quality Control (AQC) units with four sorting arms, each linked to a different VIS. In May, BHS sold two AQC-4 units (the "4" denotes four arms) to an unnamed PET reclaimer in Southern California.

Meanwhile, Machinex recently installed a unit with one visioning system and two sorting arms at the Sani-Éco MRF in Granby, Quebec.

Another recent innovation has been the integration of the VIS with optical sorters. From early on, representatives at robot companies emphasized their systems won't replace optical sorters, which can still perform up to 15 times the number of picks per minute that a robotic arm can. But the visioning systems – the heart of the AI robot revolution – are being used to make optical sorters smarter.

For example, BHS has two customers in Pennsylvania and one in the San Francisco region using VIS systems integrated with SpydIR optical sorters from National Recovery Technologies (NRT), a BHS company. One of those is York, Pa. MRF operator Penn Waste, which uses the VIS on an optical sorter ejecting small OCC at the beginning of the container line. The vision system distinguishes between a paper label on a bottle and cardboard. It can then tell the optical sorter not to fire on the bottle.

The physical sorting units have also undergone innovation. BHS has developed what it calls the AQC-C, which contains one or more collaborative robots, called CoBots. The difference from earlier offerings is the CoBot is designed to work alongside human sorters, reducing the need to retrofit lines and allowing it to be installed quickly. If a human sorter bumps the arm of a CoBot, the robotic arm immediately stops moving.

"Unlike the AQC, which needs more structure to support the robot and guard employees, the AQC-C can be installed in sort cabins, on narrow walkways and in other tight locations," according to a BHS press release.

The trade-off is the CoBots, which are "selective compliance articulated robot arm" (SCARA) units, aren't as fast as the delta-type robots that have been used by AMP and BHS. Each CoBot arm is capable of 40 picks per minute. For comparison, the AQC-2 units slated to be installed at CarbonLite's PET recycling plant under construction in eastern Pennsylvania are each capable of up to 60 picks per minute.

Moving into new roles

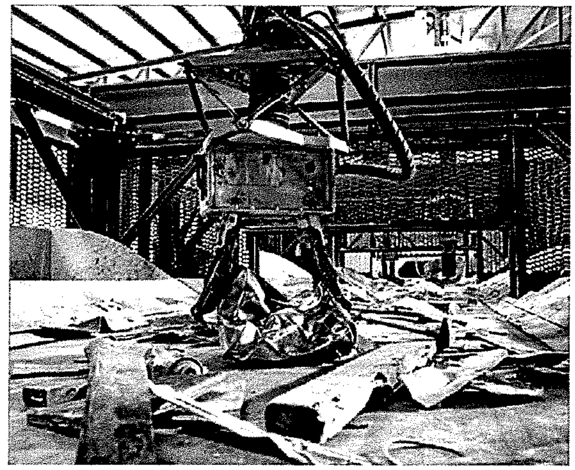
Robots have largely been deployed on quality control lines, where ample spacing between materials on the belt and a lower overall volume have allowed them to work effectively.

But Horowitz of AMP sees potential for much greater market penetration in MRFs; he estimates his company can automated three-quarters of the positions on a line. But the presort area presents problems.

On a MRF's presort line, greater material depth and high levels of commingling have been impediments to robots. A human can quickly brush aside paper to get at the bag or textile contamination below, but that's not practical for a robotic arm.

One solution may be in redesigning presort lines. Reardon said BHS has installed presort lines designed to accommodate the future installation of a robot. One system was designed with screens to provide pre-sizing, and the screen "unders" go to a belt where a robot could be installed.

Robots could also be integrated into other roles, such as automated loading of a system, Reardon noted. "The demand of the market is really any place where human labor is necessary," he said.



ZenRobotics started with a focus on C&D streams but has since designed systems for residential recyclables.

Already, robots have moved well outside the municipal recycling sphere. Over the last several months, AMP has installed sorting robots at two electronics recycling facilities owned by ERI, a nationwide IT asset disposition and e-scrap recycling company.

One of the big challenges in adapting the robot to handle shredded electronics was modifying the sorting arm, Horowitz explained. Small, folded and fractured pieces of shredded material present unique challenges in terms of securing a good vacuum grip and ensuring the suction cup is durable.

Electronics recycling isn't the only sector robots are invading.

ZenRobotics began in the C&D sorting space but is now also offering a system for sorting curbside materials. Of its six confirmed robotic systems deployed in the U.S., five are sorting C&D or other bulky materials and one is sorting household recyclables.

Meanwhile, AMP, which started by tackling residential recyclables, is moving into the C&D space, with AMP and Japanese company Ryohshin co-developing a robotic system for C&D debris. Two units have been installed in Japan, and AMP plans to market the technology in North America.

By starting in residential recyclables, AMP began with the toughest challenge, Horowitz said. Heavily burdened MRF container lines present not only a huge variety of materials but also problematic items such as bags, which gum up equipment. AMP has found that, in many ways, other streams are easier because they're more consistent, he said. AMP is exploring still other applications, including organics and automotive scrap sorting.

The same goes for BHS and Machinex. Both Hawn of Machinex and Reardon of BHS said they see opportunities in e-scrap, C&D debris and elsewhere.

Horowitz said his early predictions of how robots could improve recycling have proven true.

"We've been really fortunate to see a lot of industry demand come out of it," said AMP's Horowitz. "We always thought the robots would be a big deal for recycling, but the quick uptake of the systems has been ... a rewarding surprise for me personally."

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