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The Future of Recycling Is Sorty McSortface

It's really hard to sort all the junk that gets thrown in recycling bins. Do tech startups have the answer?

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At the Boulder County Recycling Center in Colorado, two team members spend all day pulling items from a conveyor belt covered in junk collected from the area's bins. One plucks out juice cartons and plastic bottles that can be reprocessed, while the other searches for contaminants in the stream of paper products headed to a fiber mill. They are Sorty McSortface and Sir Sorts-a-Lot, AI-powered robots that each resemble a supercharged mechanical arm from an arcade claw machine. Developed by the tech start-up Amp Robotics, McSortface and Sorts-a-Lot's appendages dart down with the speed of long-beaked cranes picking fish out of the water, suctioning up items they've been trained to recognize.

Yes, even recycling has gotten tangled up in the AI revolution. Amp Robotics has its tech in nearly 80 facilities across the U.S., according to a company spokesperson, and in recent years, AI-powered sorting from companies such as Bulk Handling Systems and MachineX has popped up in other recycling plants. These robots are still niche, but they're starting to be seen as a step forward for an industry in need of real improvement. "I know it's kind of a buzzword," says Jeff Snyder, the director of recycling at Rumpke Waste and Recycling, a waste-management company based in Ohio. "But from an [industry] perspective, AI is incredible. It's a game changer for us."

In the ChatGPT era, AI has been endlessly hyped as tech companies scramble to profit off the recent surge of interest. But the technology's impact on recycling might be closer to the opposite: a meaningful application that is hidden in plain sight. Even that might still not be enough to fully fix recycling as we know it.

Recycling could use a high-tech shake-up. In theory, "materials recovery facilities," or MRFs—industry insiders pronounce the acronym as a word that rhymes with *Smurfs*—are supposed to close the loop between consumption and production. They gather

the containers and pieces of packaging we throw into bins, do the dirty work of sorting them out, and then sell those materials back to other companies that can reuse them.

In practice, the MRFs aren't all that good. In 2018, only about a third of all glass containers were successfully recycled in the U.S. That same year, the EPA estimated that less than 9 percent of plastics were recycled, and the number may have fallen since then. In recent years, China, which historically bought much of America's recyclable scrap, has largely stopped buying it—in part, because the end product of recycling tends to be a mix of different kinds of items that can't be feasibly reused together. Since then, a few other countries have picked up some of the slack, but not all. With nowhere to send huge quantities of recyclables, many communities have simply started to burn and landfill what used to go to China.

The issue is that it's long been too hard for recycling plants to sort material with the level of specificity needed to satisfy manufacturers that could theoretically reuse it, Matt Flechter, a recycling specialist for Michigan, told me. The traditional recycling methods used to sort waste—including sieves, blasts of compressed air, glass crushers, powerful magnets, and near-infrared light—do a good job of separating waste into broad categories of paper, glass, and metal. But finer layers of detail often go unnoticed, especially with plastic. It's hard for recyclers to determine whether, say, a #2 HDPE container is a milk jug, which would be suitable for reuse in food products, or a pesticide container, which wouldn't be, as thousands of pounds of refuse whizz down the line at 600 feet a minute. Although plastic bottles and plastic clamshells are each recyclable, a poorly sorted mix of them is something no one really wants.

AI stands to change that calculus, giving recycling plants a far more granular view into packaging that otherwise tends to be hopelessly commingled. These recycling bots—from Amp and competitors such as MachineX, Bulk Handling Systems, Glacier Robotics, and Everest Labs—are “vision systems”: In the same way that ChatGPT is trained by ingesting text that has been published online, they absorb lots of photographs of tossed-out items in various states of degradation and disrepair. The

robots are then able to identify even tiny differences in a product's color, shape, texture, or logo—and in the case of Amp, even its SKU, the unique number manufacturers assign to each kind of item they sell, Matanya Horowitz, Amp's CEO, told me. "We know this is Procter and Gamble, this is Unilever, and so on," Horowitz said. "If we know the SKU, we can determine anything—I know what adhesive they used; I know what cap they used; I know what was actually in it."

The bots are helping to create new end-markets that didn't exist before, recycling operators told me, thanks to their ability to sort types of plastic that otherwise might get downcycled or trashed. Operators said that systems currently tend to be 85 to 95 percent accurate, while robotics companies themselves claim up to 99 percent accuracy. Steve Faber, a representative for Michigan's Kent County Department of Public Works, which operates a recycling facility in Grand Rapids, said Amp's bots have allowed the plant to sort out and resell #5 polypropylene, a plastic used in coffee pods and other lightweight food containers, that were previously getting sorted into mixed bales with next to no value.

Recycling robots have been around for a few years, but their momentum seems to be growing during the current AI boom. Waste Management, the largest residential-recycling company in the U.S., has announced plans to invest \$800 million in recycling infrastructure by the end of 2025, including new, AI-powered facilities. At the same time, the companies that design this tech are starting to raise serious money—especially Amp, whose \$99 million Series C round has seen buy-in from Google Ventures, the Microsoft Climate Innovation Fund, and Sequoia Capital.

That is not to say that the turn to AI has *already* fixed recycling. The high-tech systems that are needed to keep up with the torrent of recyclables won't come cheap—an individual robot can cost as much as \$300,000, and investments can take years to recoup. Many facilities, Flechter said, are reluctant to adopt the newer approaches because the price tag means they often lose money, and some communities are already too cash-strapped to offer recycling services at all.

Still, as costs eventually decrease, the future looks promising, heralding more than just robots with mechanical arms. Snyder, of Rumpke, thinks AI's bigger contribution will be to reinvent "high-volume optical sorting," an approach that uses near-infrared light to determine a product's material composition before a blast of air diverts it down various chutes. It is faster than the recycling robots, but so far lacks the same kind of accuracy. A version with an AI vision system would be *both* ultra-quick and ultra-


accurate. In partnership with MachineX, Rumpke is in the process of building one of the earliest plants with such technology. When its \$90 million facility in Columbus, Ohio, opens in 2024, it will be able to process a full ton of material every minute and 250,000 tons a year.

In a decade, recycling bots could be everywhere, helping facilities churn out perfectly sorted bales of junk that companies can turn into something new. But recycling, even souped up with AI and robotics, will always have limitations. Recycling tech can treat only the symptoms of unconstrained consumerism, not the disease of companies that are dumping far too many single-use products into the world. A few states have begun passing laws that shift the financial burden of collection and reuse back onto packaging producers through hefty fines, but for the most part, “the assumption is that industry can make whatever it wants, and then the recycling industry has to figure out how to deal with it,” says Suzanne Jones, the executive director of Ecocycle, the nonprofit that operates the recycling facility in Boulder. “And that’s backwards.”

At worst, recycling bots could give companies an opportunity to greenwash their reputation. Advances in AI could allow brands to claim their materials are theoretically recyclable, when in practice they aren’t—and when what’s really needed is more money in the system. Some modest efforts are under way to do just that. The Polypropylene Recycling Coalition—a group funded by companies such as Campbell’s, Nestle, and Keurig Dr. Pepper—has since 2020 spent more than \$10 million to improve polypropylene collection at 41 facilities in the U.S, including a rollout of new AI-enabled robotic sorters that specifically target that material.

It’s a start, though \$10 million barely registers compared with America’s \$91 billion waste-and-recycling industry. Of course, from a plastics-pollution perspective, what’s better than a recyclable K-cup is not using a K-cup at all. Recycling bots can’t change the basic fact that recycling, even at its best, is just not a particularly efficient way of dealing with single-use products, no matter how much we might want to believe that it is. Even in this new era of AI, tech alone can only go so far. The more things change, it seems, the more they stay the same.

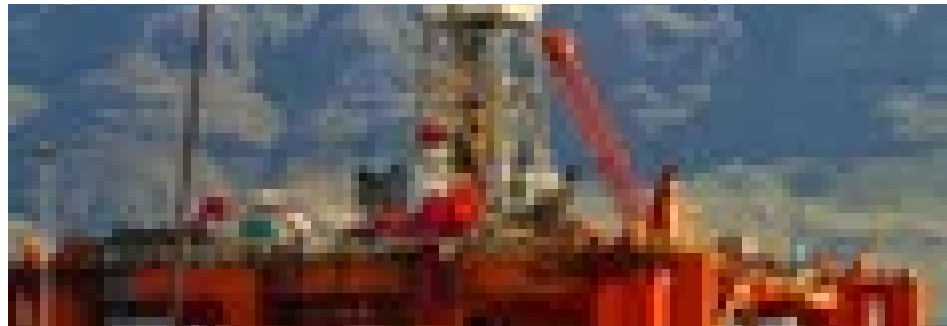
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